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Wastewater Handbook
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EXECUTIVE SUMMARY

Adequately managed decentralized wastewater systems are a cost-effective and long-term option for meeting public health and water quality goals, particularly in less densely populated areas. Small communities' wastewater needs are currently 10 percent of total wastewater demands. Decentralized systems serve approximately 25 percent of the U.S. population, and approximately 37 percent of new development. This document addresses the Congressional House Appropriations Committee's request that EPA report on:

(1) the Agency's analysis of the benefits of decentralized wastewater system alternatives compared to current (i.e., centralized) systems;
(2) the potential savings and/or costs associated with the use of these alternatives;
(3) the ability of the Agency to implement these alternatives within the current statutory and regulatory structure; and
(4) the plans of the Agency, if any, to implement any such alternative measures using funds appropriated in fiscal year 1997.

Also addressed in this response is the Committee's inquiry on the role of Rural Electric Cooperatives in upgrading rural drinking water and wastewater facilities.

BACKGROUND

Well through the first half of this century, wastewater management entailed either centralized collection sewers with some type of treatment facility for the highly populated areas, or conventional onsite systems (or sometimes cesspools) for small towns, suburban and rural areas. With the passage of the Clean Water Act (CWA), P.L. 92-500 in October 1972, which contained a national policy to provide funding for publicly owned treatment works and a goal to restore our lakes and streams, most communities selected centralized systems which were eligible for funding by the federal government. The 1977 amendments to the CWA required communities to examine or consider alternatives to conventional systems, and provided a financial set-aside for such treatment systems to be built. Approximately 2,700 facilities utilizing innovative and/or alternative technologies were constructed through this grant program which ended in 1990. Incentive set-aside funding was not continued under the Clean Water State Revolving Fund (SRF) program. Given the billions of dollars in remaining needs for upgraded and new wastewater facilities (EPA, 1993), communities must look even closer at alternative technologies for meeting their needs.

One area of concern is failing or obsolete wastewater systems in less densely populated areas. When these systems were first built, common practice was to install the least costly solution, which was not necessarily the most appropriate solution for the conditions. For a variety of reasons, these systems are failing. Both centralized and decentralized system alternatives need to be considered in upgrading failing systems to provide the most appropriate and cost-effective solution to wastewater treatment problems. This document addresses the issues raised when considering decentralized treatment options.

BENEFITS OF DECENTRALIZED SYSTEMS

Decentralized systems are appropriate for many types of communities and conditions. Cost-effectiveness is a primary consideration for selecting these systems and is summarized below. A list of some of the benefits of using decentralized systems follows:

- Protects Public Health and the Environment. Properly managed decentralized wastewater systems can provide the treatment necessary to protect public health and meet water quality standards, just as well as centralized systems. Decentralized systems can be sited, designed, installed and operated to meet all federal and state required effluent standards. Effective advanced treatment units are available for additional nutrient removal and disinfection requirements. Also, these systems can help to promote better watershed management by avoiding the potentially large transfers of water from one watershed to another that can occur with centralized treatment.

- Appropriate for Low Density Communities. In small communities with low population densities, the most cost-effective option is often a decentralized system.

- Appropriate for Varying Site Conditions. Decentralized systems are suitable for a variety of site conditions, including shallow water tables or bedrock, low-permeability soils, and small lot sizes.

- Additional Benefits. Decentralized systems are suitable for ecologically sensitive areas (where advanced treatment, such as nutrient removal or disinfection is necessary). Since centralized systems require collection of wastewater for an entire community at substantial cost, decentralized systems, when properly installed, operated and maintained, can achieve significant cost savings while recharging local aquifers and providing other water reuse opportunities close to points of wastewater generation.

POTENTIAL COSTS AND SAVINGS

Decentralized onsite and cluster wastewater systems can be the most cost-effective option in areas where developing or extending centralized treatment is too expensive (e.g., rural areas, hilly terrain). Cost estimates on a national basis for all decentralized systems are difficult to develop due to the varying conditions of each community. The comparisons presented in this document suggest that decentralized systems are typically cost-effective in rural areas. For small communities and areas on the fringes of urban areas, both decentralized and centralized systems (or combinations) can be cost-effective, depending on the site conditions and distance to existing sewers.

OVERCOMING BARRIERS TO IMPLEMENTING DECENTRALIZED SYSTEMS

Several barriers, listed below, inhibit the expanded use of decentralized wastewater systems. Suggested ways to overcome the barriers are also provided. The barriers and suggestions address a wide range of issues and apply to the various organizations associated with implementing decentralized systems.

- Lack of Knowledge and Public Misperception. The perception of some homeowners, realtors, and developers that centralized systems are better for property values and are more acceptable than decentralized systems, even if they are far more costly, makes it difficult to demonstrate that properly designed and managed decentralized systems can provide equal or more cost-effective service. Also, many regulators and wastewater engineers are not comfortable with decentralized systems due to a lack of knowledge. Decentralized systems, particularly the non-conventional types, are not included in most college and technical instructional programs.

  Overcoming the Barrier. Professional training and certification programs should include decentralized treatment systems. Educational materials for homeowners should explain proper operation and maintenance practices and the consequences of failures.

- Legislative and Regulatory Constraints. State enabling legislation that provides the necessary legal powers for carrying out important management functions may be absent, vague, or not clearly applicable to decentralized systems. Most importantly, in almost all states, legislative authority for centralized and decentralized wastewater systems is split between at least two state agencies. It is also common for legislative authority for decentralized systems to be split between state and local governments, resulting in further confusion regarding accountability and program coordination. Under these conditions, decentralized wastewater systems have not gained equal stature with centralized facilities for public health and environmental protection.

  Many states and localities also rely on inflexible and prescriptive regulatory codes for decentralized systems, and often allow only the use of conventional septic systems. Where alternative systems are approved, approval often involves a lengthy process. As a result, an onsite system that may be inadequate (because the system could not operate under the special site conditions) or a needlessly expensive centralized system or expansion may be selected.

  Overcoming the Barrier. States should be encouraged to develop or improve enabling legislation that allows the creation of management agencies and empowers new or existing organizations to carry out management functions for decentralized wastewater systems. Also, states should consider consolidating legal authority for centralized and decentralized wastewater systems under a single state agency so that all wastewater management options are reviewed more equitably.

State and local regulatory codes should be revised to allow the selection of decentralized systems based on their ability to meet public health and environmental protection performance standards, just as centralized systems are now. The development and use of model codes can facilitate this process.

- Lack of Management Programs. Few communities have developed the necessary organizational structures to effectively manage decentralized wastewater systems, although such management programs are considered commonplace for centralized wastewater facilities and for other services (e.g., electric, telephone, water). Without such management, decentralized systems may not provide adequate treatment of wastewater.

  Overcoming the Barrier: Management programs should be developed on state, regional, or local levels, as appropriate, to ensure that decentralized wastewater systems are sited, designed, installed, operated, and maintained properly and that they continue to meet public health and water quality performance standards. Examples of possible management structures (see Appendix C) should be provided to municipalities (e.g., public ownership/private maintenance). Examples of successful attempts of implementing management programs should be highlighted (see Appendix E for case studies).

- Liability and Engineering Fees. Homeowners and developers are often unwilling to accept the responsibility and potential liability associated with unfamiliar systems such as those providing decentralized treatment. Also, engineers' fees are often based on a percentage of project cost and have little incentive for designing low cost systems.

  Overcoming the Barrier. Liability can be addressed within the context of a management plan which will prevent failures and develop mechanisms to cover failures. Engineering fees should not be based on project cost for decentralized systems.

- Financial Barriers. EPA's Construction Grants program, and now the Clean Water SRF program, have been the major source of wastewater treatment facility funding. These programs are generally available only to public entities. Difficulties exist for privately-owned systems in obtaining public funds under current federal and state grant and loan programs.

Overcoming the Barrier. There are a number of other federal sources of funding for private entities. The U.S. Department of Agriculture's Rural Utility Service provides funding through its Water and Waste Disposal loan and grant program to public entities, Indian tribes, and organizations operated on a not-for-profit basis, such as an association, cooperative, or private corporations. Two EPA programs, the Clean Water SRF program for nonpoint source control and the CWA section 319 program, are also available to private entities. Public grant and loan funds for wastewater management should be utilized to a greater extent to manage decentralized wastewater systems where eligible. Education for community officials should be provided on the these eligibilities.

EPA'S ABILITY AND PLANS TO IMPLEMENT

Over the past 20 years, EPA has put considerable resources into helping small communities meet their wastewater needs. This has been accomplished in many ways -- financing, public education, technical assistance, technology transfer, research, demonstrations, and assistance with program development. Most of the outreach, which includes technical assistance and education has been grouped under the umbrella of EPA's Small Community Outreach and Education Program (SCORE). Assistance has also been provided indirectly through federal funding of the many associations that have come together to support small community needs. Many of these efforts continue today and will continue into the future. Described below are ongoing and planned activities and programs conducted by EPA or with EPA assistance, which provide a framework for implementing alternatives such as decentralized treatment systems.

Funding

- Technologies funded under the Innovative and Alternative Technology provisions of the Construction Grants program are being assessed under a technology assessment program which will produce technical documents and fact sheets on various technologies.

- The Clean Water State Revolving Fund program has funded decentralized systems in several states since the expiration of the Construction Grants Program. Loans are also available for nonpoint source activities, including planning, design and construction activities associated with correcting onsite system problems.

- EPA is working with USDA's Rural Utility Service and HUD to provide funding to communities in a more efficient and less burdensome manner. Improved coordination and cooperation between the Agencies is outlined in a memorandum that is in the process of being signed by the three Agencies. Follow-up actions to implement improvements will be undertaken in fiscal years 1997 and 1998.

- EPA has recently announced a Hardship Grants Program for Rural Communities which will fund wastewater treatment in communities not served by centralized wastewater collection or treatments systems. Decentralized systems may be the option of choice for these rural, dispersed communities. The program can also fund training programs that, among other things, can assist in the development of management districts.

Outreach and Education

- EPA provides yearly funding for the National Small Flows Clearinghouse to provide a wide range of technical assistance.

- The Small Towns Environmental Program (STEP) encourages the use of small alternative systems through a grass-roots, self-help program.

- The National Environmental Training Center for Small Communities (NETCSC) supports environmental trainers through development and delivery of training curricula and training of trainers.

- The Rural Community Assistance Program provides technical assistance to rural communities.

Technology and Demonstrations

EPA's technology and demonstration programs, in collaboration with other stakeholders, provide technical guidance through the following projects:

- National Onsite Demonstration Project
- Updates of EPA design manuals on Onsite Systems, Small Community Technologies and Constructed Wetlands; and a guidance document for Large Capacity Septic Systems
- Grants under the Environmental Technology Initiative to demonstrate onsite technologies
- A grant to develop a research agenda for onsite treatment
- A small community wastewater testing and verification center under EPA's Environmental Technology Verification (ETV) program (discussions are underway)

Program Development

- EPA plans to collaborate with other federal agencies to develop guidance to assist communities in implementing management systems based on performance goals.

- EPA is also encouraging planning and implementation on a watershed basis to meet water quality goals. Improved decentralized treatment is an important component of many of these plans.

THE ROLE OF RURAL ELECTRIC COOPERATIVES IN UPGRADING FACILITIES

Rural electric cooperatives are private entities that build and manage extensive rural utility systems. These cooperatives have the capability to address a full range of technical, financial, administrative, and regulatory issues related to the supply and management of electric power. In the Fiscal Year 1997 House Appropriations Committee report, the Committee acknowledged the significant interest of the cooperatives "to expand their current role of delivering electricity to the delivery to rural communities of clean water and safe drinking water improvement technologies as well." The Committee "is uncertain whether expansion into this new field is an appropriate means of upgrading rural drinking and wastewater facilities to meet federal requirements." EPA was asked to review this matter and report on its findings prior to the Committee's fiscal year 1998 budget hearings for EPA. The review is presented as an appendix to this response (Appendix F).

In summary, drinking water and wastewater treatment facilities can be upgraded and managed by rural electric cooperatives, although 13 states would require enabling legislation for them to own and/or operate drinking water and wastewater facilities. Cooperatives could be a good solution in rural areas because cooperatives are non-political, known entities to the homeowners, that bring experienced management and staff to solve the O&M challenge, as well as options for obtaining capital. The ability to provide management services, including O&M, can be the cooperatives' most valuable asset.

From the drinking water perspective, cooperatives offer great promise as management entities for small water systems which lack institutional strength. However, for many reasons, it is unlikely that more cooperatives will make significant movements into the drinking water and wastewater business quickly. These reasons involve the interest on the part of individual owners to pay for onsite system management, the technical ability of the cooperative to manage drinking water and wastewater facilities, limited experience with low energy onsite technologies, and the ability to obtain capital. Once these issues are resolved, the community and cooperative may be able to work together to efficiently provide the needed wastewater services.

Chapter 1

INTRODUCTION

PURPOSE

This document addresses the Congressional House Appropriations Committee's request that EPA report on

(1) the Agency's analysis of the benefits of decentralized wastewater system alternatives compared to current (i.e., centralized) systems;
(2) the potential savings and/or costs associated with the use of these alternatives;
(3) the ability of the Agency to implement these alternatives within the current statutory and regulatory structure; and
(4) the plans of the Agency, if any, to implement any such alternative measures using funds appropriated in fiscal year 1997.

Appendix F addresses the Committee's request to analyze the ability of rural electric cooperatives to upgrade facilities in rural areas. A separate response addresses privatization of municipal wastewater facilities, also requested by the Committee.

Responses to areas 1 through 4 are presented below. Following this Introduction is an analysis of the benefits of implementing decentralized treatment options (#1 above). It focuses on the factors that influence the selection of a wastewater system in a community and the conditions under which a decentralized or centralized system would be the best option. This is followed by an analysis of the potential costs and savings (#2 above) which examines comparative costs for centralized and decentralized wastewater systems using two hypothetical scenarios. Next, the document highlights barriers that inhibit the expanded use of decentralized systems and suggestions for overcoming the barriers. A section follows describing EPA's ability and plans to implement the findings (questions #3 and #4 above), with appendices supplementing the text.

The House Appropriations Committee request highlighted several alternative approaches for managing wastewater, including:

- Targeted upgrades of treatment systems failing at individual homes.
- Innovative, high-performance technologies for pretreatment on lots characterized by shallow soils or other adverse conditions.
- Small satellite treatment plants or leaching fields in high-density areas.
- Detailed watershed planning to specify precise standards for sensitive versus non-sensitive zones.

- Maintenance, inspection, and water quality monitoring programs to detect failures in onsite systems.

These approaches are discussed throughout this document, particularly in the "Analysis of Benefits" section. Targeted upgrades of failing onsite systems are discussed in a variety of contexts, including the section on "Lower Capital Costs for Low Density Communities", which discusses why decentralized systems are most applicable for upgrading failing systems in small, rural communities and in ecologically sensitive areas. Examples of innovative or alternative technologies that provide additional treatment for sites with shallow soils and a variety of other hydro geological conditions are given in the section "Adaptable to Varying Site Conditions" and many such systems are described in Appendix A, "Definitions and Descriptions of Wastewater Systems." Small satellite treatment plants or leach fields which have low cost collector sewers are referred to as "cluster systems" or "package plants" throughout this report. Watershed planning and standards for targeting ecologically sensitive areas are discussed in the section on "Additional Benefits" and in Appendix B under "Comprehensive Planning." Maintenance, inspection, and monitoring programs are described in several sections related to management systems and Appendix C on "Management Systems."

SELECTED DEFINITIONS

Appendix A provides detailed definitions of many terms used in this document. There are several terms which are used extensively throughout this document and are defined here as well as in Appendix A.

- A **decentralized system** is an onsite or cluster wastewater system that is used to treat and dispose of relatively small volumes of wastewater, generally from individual or groups of dwellings and businesses that are located relatively close together. Onsite and cluster systems are also commonly used in combination.

- An **onsite system** is a natural system or mechanical device used to collect, treat, and discharge or reclaim wastewater from an individual dwelling without the use of community-wide sewers or a centralized treatment facility. A conventional onsite system includes a septic tank and a leach field. Other alternative types of onsite systems include at-grade systems, mound systems, sand filters and small aerobic units.

- A **cluster system** is a wastewater collection and treatment system where two or more dwellings, but less than an entire community, are served. The wastewater from several homes may be pretreated onsite by individual septic tanks or package plants before being transported through low cost, alternative technology sewers to a treatment unit that is relatively small compared to centralized systems.

HISTORY OF WASTEWATER MANAGEMENT

Onsite wastewater systems have been used since the mid-1800s, with technological advances improving the systems from simple outhouses to cesspools, to septic tanks, to some of the more advanced treatment units available today. In the 1970s and 1980s, large Federal investments in the construction of wastewater facilities focused primarily on large, centralized collection and treatment systems rather than on decentralized systems. Federal funds for wastewater systems increased significantly in 1972, as authorized in the Federal Water Pollution Control Act (later called the Clean Water Act). Municipalities used funds from the new Construction Grants program to build sewers and centralized treatment facilities to meet national standards for discharged pollutants (GAO, 1994). Between 1972 and 1990, the federal government spent more than $62 billion in this program for constructing or upgrading treatment facilities (Lewis, 1986).

The initial decision to install a particular system (i.e., hookup to a centralized system or use onsite systems) was primarily made in the private sector by the developer of a property, based on affordability or profitability. In small communities, developers often chose more affordable onsite systems which could be easily installed for each dwelling. Once installed, the onsite system was usually not examined again unless an emergency situation arose, with wastewater either backing up into backyards or streets even though in many cases, they were contributing to pollution of ground water and nearby surface waters. In most small communities, outdated state and local regulatory codes still promote the continued use of poorly maintained conventional onsite systems (a septic tank and leach field). In many of these communities, these systems are providing adequate public health and environmental protection, but in many cases, they are not.

The 1990 Census indicates that 25 million households use conventional onsite systems or cesspools. Data on the failure rate associated with these systems is limited; a national estimate is not available. However, during 1993 alone, a total of 90,632 failures were reported, according to a National Small Flows Clearinghouse survey of health departments across the country. Failure rates as high as 72 percent have been documented, such as in the Rouge River National Demonstration Project. Nationwide data show that failures of onsite wastewater systems are primarily due to improper siting (e.g., in low-permeability soils), improper design, poor installation practices, insufficient operation and maintenance of the systems, and lack of enforcement of codes. Some communities, such as Stinson Beach, CA (see Appendix E) and Warwick, RI, explored ways to prevent future failures, including managing decentralized systems to ensure that they were operated and maintained appropriately, and using alternative types of systems where site conditions made conventional onsite systems marginally applicable. During the 1970's, a number of state and local governments, including Gardiner, NY and Wood County, WV, with the support of the U.S. EPA Research and Development programs, experimented with different types of decentralized systems that could accommodate a variety of site and community conditions and meet environmental protection goals if properly operated and maintained. Subsequently, in the 1980's, the Innovative and Alternative (I&A) Technology and Small Community set-asides of the Construction Grants program resulted in the construction of hundreds of small community technologies using centralized and decentralized approaches. Both programs provided some information on performance and costs of newer decentralized systems.

Circumstances changed in 1990, when the federal Construction Grants and I&A programs were eliminated. These programs were replaced by the Clean Water State Revolving Fund program, which provides communities with low interest loans. These programs have only been able to meet a small portion of the total needs. EPA's 1992 Needs Survey estimated the nation's documented wastewater needs to be $137 billion, with an increase of 39 percent from 1990 to 1992 (EPA, 1993). Small community needs comprised approximately 10 percent (over $13 billion) of total unmet needs in 1992. Furthermore, EPA estimated that replacing failing septic systems with new centralized system sewers and treatment facilities accounted for 40 percent of the small community needs (EPA, 1993).

Managed decentralized wastewater systems are viable, long-term alternatives to centralized wastewater facilities where cost-effective, particularly in small and rural communities. Decentralized systems already serve one-quarter of the population nationwide, and 50% of the population in some states. These systems merit serious consideration in any evaluation of wastewater management options for small and mid-sized communities and new development. In some cases, combinations of decentralized and centralized arrangements will be useful to solve diverse conditions.

Chapter 2

ANALYSIS OF BENEFITS

WASTEWATER SYSTEM GOALS

Wastewater systems have two fundamental goals:

- o Protection of public health (e.g., from waterborne disease-causing organisms such as bacteria; from high nitrate levels in ground water).
- o Protection of the environment (e.g., protection of surface waters from eutrophication caused by excess phosphorus and nitrogen).

If properly sited, designed, installed and managed over their service lives, decentralized wastewater systems can, and do, meet both public health and environmental protection goals in areas where centralized treatment is impractical or not cost-effective. This section discusses why a decentralized system is often the most feasible choice for small communities.

The Clean Water Act, as amended, identifies federal requirements for wastewater treatment facilities discharging to waters of the U.S., i.e., a minimum of secondary treatment and water quality standards. Decentralized systems which discharge to a surface water must, and can, meet these requirements. Conventional onsite systems discharge effluent through the soils to the groundwater. Groundwater can be protected with properly maintained onsite systems or with additional treatment to control nutrients.

In addition, the Safe Drinking Water Act addresses the risk to groundwater quality posed by the large capacity septic systems (systems with the capacity to serve 20 or more persons per day). EPA includes large capacity septic systems as a type of Class V well which are regulated within the Underground Injection Control program to protect ground waters.

BENEFITS OF DECENTRALIZED WASTEWATER SYSTEMS

For certain communities and site conditions, managed decentralized wastewater systems are the most technically appropriate and economical means for treating wastewater when compared to centralized treatment systems. The primary benefits of using decentralized systems are:

- o Protects public health and the environment
- o Lower capital and maintenance costs for low density communities
- o Adaptable to varying site conditions
- o Additional benefits

How these factors affect the selection of wastewater systems is discussed below. For a more detailed discussion of cost-effectiveness, see the "Potential Costs and Savings" section of this document.

Protects Public Health and the Environment

Properly managed decentralized wastewater systems can provide the treatment necessary to protect public health and the environment including groundwater and surface waters, just as well as centralized systems. Decentralized systems can usually be sited, designed, installed and operated to meet all federal and state required effluent standards for biological oxygen demand (BOD), total suspended solids (TSS) and fecal coliform. Effective advanced treatment units are available for additional nutrient removal and disinfection requirements for both types of systems, as well.

Centralized systems frequently result in large watershed transfers of waters, whereas decentralized systems when used effectively promote the return of treated wastewater within the watershed of origin. Managed decentralized systems can effectively minimize the impacts of these interbasin water transfers.

Lower Capital and Maintenance Costs for Low Density Communities

In areas with low population densities (approximately one dwelling or less per acre), decentralized onsite wastewater systems often are the most cost-effective option for upgrading failing septic systems or serving new development. Constructing new centralized systems in rural areas is often economically unfeasible because of the distances between homes, the significant piping required to tie-in all the connections, and the inability to achieve economies of scale (i.e., a certain number of users to support system costs).

In urban and suburban areas with high population densities (more than three to four dwellings per acre), large-scale, centralized collection and treatment of wastewater is usually most cost-effective.

For areas with moderate population densities (one dwelling per one-half to one acre) located at moderate distances from a centralized treatment facility, the choice of a centralized or decentralized wastewater system may vary by neighborhood based on local conditions. Moderately populated areas may effectively use decentralized cluster wastewater systems that serve two or more (up to several hundred is possible) homes and are located close to the dwellings they serve. These cluster systems are cost-effective in many cases because they use smaller, less expensive collection pipes that travel relatively short distances to smaller, less maintenance intensive treatment units (often with soil disposal or reuse of effluent). As long as homes are relatively close together, cluster systems may be cost-competitive with numerous individual onsite systems.

Adaptable to Varying Site Conditions

In the past, when fewer types of decentralized wastewater systems were available, certain site conditions, such as high ground-water tables, impervious soils, shallow bedrock or limestone formations, were considered limiting factors that precluded decentralized systems. In many cases, septic tank/leach field systems were nonetheless used at many such sites, with inadequate subsequent protection of surface and ground water. Today, however, decentralized systems can usually be designed for a specific site and its hydrogeological conditions. For example, sand mounds systems are designed specifically for sites with high ground water. Decentralized wastewater systems now allow greater flexibility and are often combined into treatment trains to meet a range of treatment goals and site conditions. A treatment train might include a septic tank and recirculating sand filter (or other types of technologies) to greatly reduce BOD, TSS, nitrogen, and bacteria levels; a relatively small leach field (a larger leach field becomes unnecessary with the additional treatment provided by a sand filter or other treatment units); and multiple dosing of effluent to the leach field on sites with excessively permeable soils.

Additional Benefits

Decentralized systems can be advantageous in ecologically sensitive areas, where treatment must be specifically targeted to local environmental concerns (e.g., ground water protection and protection of off-shore shellfish beds or where construction of centralized collection systems may disrupt the ecosystem). Also, most decentralized onsite systems inherently include on-lot water reuse and ground-water recharge. The wastewater can be treated by decentralized systems to a specified level and then retained for reuse near (usually outdoors) the home or facility (e.g., outside for irrigating the landscape). Such reuse is most common in industrial settings and is beginning to occur in commercial settings (e.g., office parks, golf courses); however, certain types of industrial facilities may require pretreatment if wastes are toxic. In certain water-short states (e.g., Arizona, California, Florida, Texas), such reuse is even practiced in residential settings.

CONCLUSION

Communities Can Use Combinations of Decentralized Wastewater Systems

For communities with a diversity of locales, the best option might be to use a combination of wastewater systems. For example, in more densely populated areas, hookup to a centralized facility might be most cost-effective. Decentralized cluster systems could be chosen for less densely populated fringe areas currently under development and for use in ecologically sensitive areas. Onsite systems could be used in the more rural areas. Considering all possible options and their combinations is the best approach to managing wastewater needs to achieve the most cost-effective solution for a variety of site conditions and community goals.

Chapter 3

POTENTIAL COSTS AND SAVINGS

Cost is a key factor that affects the selection of wastewater management options for a community. The cost of these options varies depending on specific community characteristics, including population size and density, topography, distance to an existing treatment facility, and local performance requirements. These variables make it difficult to present a valid national comparison of costs for decentralized and centralized systems. To illustrate the differences in the cost-effectiveness of various technology options, cost estimates were developed for two hypothetical communities. Several components of the cost estimates presented may vary considerably from community to community, and may impact the cost-effectiveness of one technology option over another option. For example, land costs vary regionally and may be prohibitive in some communities for construction of large treatment facilities.

Descriptions of the two hypothetical communities on which cost estimates were based are presented below, followed by a summary of the technology options considered for different areas in the communities with different population and site characteristics; and a comparative summary of costs for different types of wastewater management options.

Costs are based on a variety of sources, including cost equations for centralized collection developed by Dames and Moore (based on Smith, 1978); centralized treatment costs presented in the WAWTTAR computer model developed at Humboldt State University (Gearheart et al., 1994); costs for small diameter gravity sewers presented in EPA documents (EPA, 1991; EPA Region IV, n.d.) and in Abney, 1976; cluster treatment costs presented in Abney, 1976 and Otis, 1996; onsite system treatment and operation and maintenance costs used in the COSMO computer model, developed at North Carolina State University (Renkow and Hoover, 1996); average land purchase costs, based on data for North Carolina; and equipment and labor costs based on data from Wisconsin. A detailed description of the cost estimation methodologies used for each type of wastewater collection and treatment technology is presented in Appendix D.

COMMUNITY PROFILES

Costs are presented for (1) a hypothetical small, rural community, and (2) a hypothetical community located on the fringes of a metropolitan center (referred to as the "fringe" community). The profiles of both types of communities are described below.

Rural Community - The rural community has a population of 450 people living in 135 homes. These homes are located on 1-acre lots or larger lots and are serviced by conventional onsite wastewater systems consisting of septic tanks and leach fields; wastewater is transported from the tanks to the leach fields through gravity distribution. About 50 percent of the onsite systems (67 systems) are currently failing due to inadequate sizing, inappropriate site conditions, or lack of maintenance. As shown in Figure 1a, these 67 failing systems are located in the northeastern section of the community near a river where there is a high water table and a prevalence of soils with low permeability.

Fringe Community - The fringe community, located 10 miles from the nearest city, has a current population of 770 people in 220 homes, but is expected to grow to a total population of 1,550 people in 443 homes located on 1/2-acre lots. The existing homes are serviced by conventional onsite wastewater systems consisting of septic tanks and leach fields; wastewater is transported from the tanks to the leach fields through gravity distribution. As shown in Figure 1b, about 50 percent of the existing onsite systems (110 systems) are currently failing due to inappropriate site conditions, including a high water table and soils with low permeability, and lack of maintenance. The metropolitan area is serviced by a centralized collection and treatment facility with unused capacity (10 miles away).

For comparative purposes, costs for centralized, cluster, and decentralized onsite systems are provided for both the rural and fringe communities, as described below.

TECHNOLOGY OPTIONS AND PERFORMANCE GOALS

The technology options considered for the rural and fringe communities are summarized below. All of the options considered are assumed to be capable of achieving the secondary treatment standard of 30 mg/L for BOD and TSS, as well as disinfection goals for significant bacteria reduction; disinfection of cluster and onsite system effluent is provided by physical and biological processes as the effluent moves through the soil.

Appendix D ("Cost Estimation Methodology") provides a detailed description of each technology, the methodologies and assumptions used in developing the cost estimates, and the capital costs and annual operating and maintenance (O&M) costs for each technology. Appendix D also includes a discussion of how costs were indexed to 1995 dollars.

Rural Community - Wastewater options considered for the rural community include:

- o *Centralized system* - New conventional gravity collection servicing the entire rural community and construction of a new centralized treatment facility, with treatment consisting of a facultative oxidation pond and disinfection. This has been the most frequently used option to address the small community problems described in this report.

- o *Cluster systems* - New alternative collection (small diameter gravity sewers [SDGS]) and construction of new small cluster treatment systems, each consisting of a sand filter and a central leach field (cluster systems would be installed only where onsite systems are currently failing; properly functioning onsite systems would continue in use).

- *Onsite systems* - Replacement of failing conventional onsite systems (septic tanks and leach fields) with new onsite systems consisting of septic tanks, intermittent sand filters where necessary, and leach fields; low pressure pipe (LPP) distribution would be used to transport the wastewater from the septic tanks up to, and through the leach fields. The sand filters and LPP distribution address the issues of a high ground-water table and low-permeability soils.

Fringe Community - Wastewater options considered for the fringe community include:

- *Centralized system* (two options considered) - A new conventional gravity collection system connected to an existing centralized treatment facility that currently serves the main municipality. In option 1, the facility has sufficient collection and treatment capacity, and in option 2, the facility has sufficient capacity to handle the added load to the sewers, but requires additional treatment capacity. Treatment for both centralized options is provided by a sequencing batch reactor (SBR) with grit removal, screening, disinfection, and sludge disposal.

- *Cluster systems* - New alternative collection (small diameter gravity sewers [SDGS]) and construction of new small cluster treatment systems, each consisting of a central sand filter and a central leach field; for new homes, the installation of new onsite septic tanks which connect to the SDGS.

- *Onsite systems* - For existing homes, replacement of failing onsite systems with new onsite systems consisting of septic tanks, intermittent sand filters where necessary, and leach fields, with wastewater transported up to, and through the leach fields with low pressure pipe (LPP) distribution; for new homes, installation of new onsite systems consisting of septic tanks and leach fields, with wastewater transported to the leach fields with low pressure pipe distribution (LPP).

SUMMARY OF COSTS

Cost summaries and comparisons for each technology option considered are presented below. Costs include the capital costs necessary to install the system(s) and the annual costs to operate and maintain the system(s). Capital costs were annualized over 30 years (the life of the system) for each technology option using a discount rate of 7 percent (OMB, 1996). All costs are presented in 1995 dollars. Table 1 presents a summary of the estimated costs for the rural community. Similarly, Table 2 presents the costs for the fringe community.

Table 1. Summary of Rural Community Technology Costs

Technology Option[1]	Total Capital Cost (1995 $)	Annual O&M Cost[2] (1995 $)	Total Annual Cost (Annualized Capital Plus O&M - 1995 $)
Centralized systems[3]	$2,321,840 - $3,750,530	$29,740 - $40,260	$216,850 - $342,500
Alternative SDGS collection and small cluster systems[4]	$598,100	$7,290[6]	$55,500
Onsite systems[5]	$510,000	$13,400[6]	$54,500
Note: The rural community consists of 450 people in 135 homes			

[1]All technology options presented are assumed to have a 30-year life span.

[2]O&M costs include: centralized system - treatment chemicals such as chlorine and sulfur dioxide, energy to run equipment such as mixers, pumps, and aerators, and labor; cluster system - yearly inspections of onsite components including sand filter, quarterly inspections of the central leach field, 10-year pumpouts of individual septic tanks, replacement of distribution pump every 10 years; onsite systems - quarterly inspections of systems, including septic tanks, leach fields, and sand filters, pumpouts of septic tanks and replacement of distribution pumps every 10 years; the establishment of an organization to provide wastewater management assumes that maintenance of all existing and future onsite systems will be performed; therefore, the annual O&M cost estimates include costs for new systems as well as existing onsite systems that are still functioning effectively.

[3]Represents conventional gravity collection and construction of a new centralized treatment plant within the rural area, consisting of a facultative oxidation pond and disinfection; the conventional gravity collection system costed for the rural community was evaluated for two population densities (1 home per acre and 1 home per 5 acres), and therefore a range of costs are presented for this technology option.

[4]Includes intermittent sand filters and gravity distribution to leach fields where onsite systems are failing.

[5]Includes replacement of failing onsite systems with (1) onsite systems consisting of septic tanks with LPP distribution to leach fields where soils have poor drainage and (2) onsite systems consisting of septic tanks and sand filters with LPP distribution to leach fields where water table is high.

[6]O&M costs for cluster systems are lower than O&M costs for onsite systems because of the lower labor requirements for operating and maintaining a single centralized sand filter and leach field in a cluster system than for operting and maintaining up to 135 individual onsite sand filters and leach fields.

Table 2. Summary of Fringe Community Technology Costs			
Technology Option[1]	Total Capital Cost (1995 $)	Annual O&M Cost[2] (1995 $)	Total Annual Cost (Annualized Capital Plus O&M - 1995 $)
Centralized systems[3] -			
System type #1:			
at 1 mile from existing sewer	$3,322,900	$83,800	$351,600
at 5 miles from existing sewer	$5,377,800	$95,900	$529,300
System type #2:			
at 1 mile from existing sewer	$3,786,900	$83,800	$389,000
at 5 miles from existing sewer	$5,841,800	$95,900	$566,700
Alternative SDGS collection and small cluster systems[4]	$3,783,700	$18,000[6]	$322,900
Onsite systems[5]	$2,117,100	$59,240[6]	$229,900
Note: The fringe community consists of 1,550 people in 443 homes (includes future growth)			

[1]All technology options presented are assumed to have a 30-year life span.

[2]O&M costs include: centralized system - treatment chemicals such as chlorine and sulfur dioxide, energy to run equipment such as mixers, pumps, and aerators, and labor; cluster system - yearly inspections of onsite components including sand filter, quarterly inspections of the central leach field, 10-year pumpouts of individual septic tanks, replacement of distribution pump every 10 years; onsite systems - quarterly inspections of systems, including septic tanks, leach fields, and sand filters, pumpouts of septic tanks and replacement of distribution pumps every 10 years; the establishment of an organization to provide wastewater management assumes that maintenance of all existing and future onsite systems will be performed; therefore, the annual O&M cost estimates include costs for new systems as well as existing onsite systems that are still functioning effectively.

[3]System type #1 represents conventional gravity collection connected to an existing sewer and treatment system that already has adequate capacity to handle the additional load; System type #2 represents conventional gravity collection connected to an existing sewer system that already has adequate sewer capacity but requires expanded treatment capcity to handle the additional load. For both systems, treatment consists of an SBR and disinfection.

[4]Includes central intermittent sand filters and gravity distribution to central leach fields.

[5]Represents onsite systems consisting of septic tanks with LPP distribution to leach fields for new homes; replacement of failing onsite systems with (1) onsite systems consisting of septic tanks with LPP distribution to leach fields where soils have poor drainage and (2) onsite systems consisting of septic tanks and sand filters with LPP distribution to leach fields where water table is high.

[6]O&M costs for cluster systems are lower than O&M costs for onsite systems because of the lower labor requirements for operating and maintaining a single centralized sand filter and leach field in a cluster system than for operting and maintaining up to 443 individual onsite sand filters and leach fields.

Rural Community Costs - As shown in Table 1, for the rural community, the most cost-effective option for meeting performance goals is using new onsite systems to replace the old onsite systems that are failing. The newer onsite systems will include low pressure pipe distribution (LPP) to achieve effective operation in areas with poor soil drainage, and sand filter and LPP in areas with a high water table to provide additional treatment before the effluent reaches the water table. The use of cluster systems with alternative collection for the failing onsite systems is not significantly more expensive; if soils were unsuitable for onsite systems, the cluster alternative would be the best choice. As the distance between homes in the rural area increases, however, cluster system collection costs would increase. Compared to the onsite or cluster system options, centralized collection and treatment is not cost-effective.

Fringe Community Costs - A summary of the estimated costs for the fringe community is presented in Table 2, including total capital costs, annual O&M costs, and the total annual cost (i.e., annualized capital plus annual O&M) for each option.

Table 2 shows that for the fringe community, in this instance, installing new onsite systems to replace the old onsite systems that are failing and new onsite systems for new homes would be the most cost-effective option. However, construction of cluster systems with alternative collection might be the preferred option in this type of growing community where space may be limited for individual onsite systems. In cases where a fringe community is relatively close to a sewer interceptor (e.g., 1 mile), and the existing centralized collection and treatment facility can accept the additional wastewater loadings, it might be cost-effective. If a fringe community is located relatively far from a sewer interceptor (e.g., 5 miles), centralized collection and treatment may not be cost-effective, especially if treatment and collection facilities require upgrading to handle additional flows. These results are typical of fringe communities, which are often "gray" areas regarding costs; that is, depending on their proximity to existing centralized facilities and their population densities, the most cost-effective option for fringe communities often varies depending on site-specific conditions. Long term growth also may be a factor in determining the most appropriate solution. Additionally, the assimilative capacity of the receiving environment may limit the utility of centralized systems that discharge to surface waters.

CONCLUSIONS

Results of the cost analysis indicate decentralized systems, whether onsite or cluster systems, are generally cost effective means of managing wastewater in rural communities due to the distance between homes and land availability. In small communities and fringe areas of metropolitan cities, the most cost effective solution depends on population density, distance to the sewer interceptor, and availability of land. The centralized alternative can be competitive with decentralized options in fringe areas, where the distance to the intercepting sewer is less than 5 miles and the receiving water body can accommodate the additional waste load. Although excluded from this analysis, the relative costs of failure for centralized systems can be far greater, given that all wastewater is concentrated at a central location (point source).

Chapter 4

OVERCOMING BARRIERS TO IMPLEMENTING DECENTRALIZED WASTEWATER TREATMENT OPTIONS

Several important barriers currently inhibit the expanded use of decentralized wastewater systems, including:

- Lack of knowledge and misperception of decentralized systems
- Statutory and regulatory barriers at the state and local level, including:
  - Lack of enabling legislation
  - Legislative authority that is split between agencies
  - Prescriptive regulatory codes
- Lack of adequate management programs for decentralized systems in many regions
- Liability and engineering fee issues
- Financial limitations

These barriers, and steps that have or can be taken to overcome them, are discussed below.

LACK OF KNOWLEDGE AND MISPERCEPTION OF DECENTRALIZED SYSTEMS

Public health officials, engineers, regulators, system designers, inspectors and developers often possess only limited knowledge of the broad range of decentralized wastewater systems because these technologies are not adequately covered in university engineering curricula. Decentralized systems are perceived to be inadequate for meeting specified public health and water quality goals. Centralized wastewater treatment facilities meet these goals by complying with regulatory and permit standards (e.g., secondary treatment standards of 30 mg/L TSS and BOD). Appropriately sited and adequately designed and maintained, decentralized wastewater systems can meet public health and water quality goals, as well.

Typically, onsite systems are perceived as the standard septic tank and leach field (referred to as conventional onsite systems in this document). However, alternative onsite systems include other types of decentralized systems, such as mound systems or sand filters. Conventional onsite systems can pose a threat to ground water, however, these systems can be designed to alleviate the threat through retrofitting existing treatment trains or with new systems that include the appropriate unit processes (Anderson et al., 1985; Ayres, 1991; Ball, 1995; Boyle, 1995; Cagle and Johnson, 1994; Hines and Favreau, 1975; Jenssen and Siegrist, 1990; Laak, 1986; Piluk and Peters, 1994; Soltman, 1989; Tchobanoglous and Burton, 1991). Recognizing that performance standards should apply to any type of wastewater system, a few states, including Florida, North Carolina, Washington and Wisconsin, have recently begun the process of setting performance standards for decentralized systems.

Homeowners are frequently uninformed about how their conventional onsite systems work, how to maintain them, and about the potential for human health and ecosystem risks from poorly functioning systems. The prevailing public perception of conventional onsite systems is they are maintenance free. Regulators and technical professionals may have little experience with alternative systems because these technologies are not included in their educational curricula and little effective training is available.

Another factor blocking acceptance of decentralized systems is the lack of comprehensive performance and cost data, or where data is available, an evaluation of the results is needed. EPA's Innovative and Alternative Technology program yielded a limited number of technology evaluations before the program and efforts to conduct assessments ended. In 1995, EPA began to fund the assessment effort again. EPA-funded assessments and fact sheets on these technologies will be published in the near future, but these efforts will mostly cover surface water discharge technologies.

Overcoming the Lack of Knowledge Barrier. Education is critical to effective efforts to encourage the acceptance and use of decentralized systems. Those who choose, design, and use these systems need to know that they perform well if properly managed. Information on what proper management entails should be readily available and widely distributed. Professional training and certification programs should cover regulatory code requirements, system siting, soils fieldwork, design, construction, monitoring and maintenance. Federal, state, local, or private agencies can provide classroom and in-field training. Six states, Arizona, Missouri, North Carolina, Rhode Island, Texas, and Washington, currently have training programs for sanitarians and installers. Since the advent of these programs, state regulatory officials (in North Carolina, for example) have allowed the utilization of a much broader array of advanced onsite technologies under the condition that these systems are managed by professional, certified operators. Similar training and certification programs in other states are a necessary precursor to broad scale use of decentralized technologies. With the participation of nationally recognized authorities and product manufacturers and the issuance of certificates of competency, these programs could produce a well-trained field of regulators and service providers.

In addition, educational materials for homeowners should explain proper wastewater disposal and maintenance practices and the consequences of system failures. Informed, responsible homeowners would help ensure that their systems are operated and maintained properly and they will be more likely to support new management programs. Training and education to increase awareness about decentralized wastewater systems should help reduce both the number of failing systems and adverse impacts on ground and surface water.

Establishment of testing centers for verification of decentralized wastewater treatment technologies is expected in the future and can enhance the confidence that these systems will perform as designed. States would need to agree to accept the testing results from these centers.

STATE/LOCAL STATUTORY AND REGULATORY BARRIERS

Decentralized wastewater systems are primarily governed by state and local jurisdictions. Only three states do not have specific regulations governing decentralized systems (in California, Georgia, and Michigan, decentralized systems are governed at the local level) (NSFC, 1995: This reference also provides a matrix of the components of all existing state regulations for decentralized wastewater systems.) However, existing laws and regulations can be barriers to implementing decentralized systems. In many cases, states and/or localities:

- Lack adequate enabling legislation to support proper management of decentralized systems.
- Divide the legislative authority for public health and water quality protection between two or more branches of government, resulting in inequitable consideration of centralized and decentralized wastewater options and in inadequate management of decentralized systems.
- Enact prescriptive regulatory codes that narrowly define the types of wastewater systems allowed, regardless of the fact that other types of systems can meet performance and regulatory standards.

These regulatory barriers as well as recommended changes are discussed below.

<u>Lack of Enabling Legislation</u> - Agencies responsible for decentralized wastewater systems must be vested with the powers necessary to effectively manage them, such as the right to access private property to inspect systems and correct system malfunctions. But state enabling legislation may not refer to decentralized wastewater systems or it may be vague or uncertain regarding legal powers to perform important management functions. Limited or unclear authority can prevent an agency from establishing a successful management program, which is a vital factor in ensuring that decentralized systems do not fail in the future.

<u>Legislative Authority Split Between Agencies</u> - Typically, state statutes divide legal authority for wastewater systems between state departments of health which are responsible for

state sanitary codes for decentralized wastewater systems, and state departments of environmental protection which are responsible for regulations governing surface-water discharges; issuance of NPDES permits, including those for centralized wastewater facilities; and various water quality programs. In some states , some aspects of onsite system regulation resides with state planning authorities or housing development agencies. Thus, legal authority for the two types of systems fall under separate, and confusing, legal jurisdictions at a fundamental level. Regulatory officials responsible for water quality programs historically have not considered decentralized wastewater systems as an acceptable option, and certainly not an option of equal stature with centralized facilities for protection of water quality.

Legal authority often is split between state and local governments. County governments are often delegated the task of developing and managing on-site disposal programs. Delegation of tasks to local entities from state government can and does work for wastewater management. Wastewater and water quality guidance coming from a single, centralized legal authority which clarifies responsibilities and facilitates selection and management of a centralized and/or decentralized system, whichever is most appropriate for the local circumstances.

Overcoming the Legal Barriers. Several steps can be taken to develop the requisite state enabling legislation and related legal authority. Existing legislative authority and institutional structures should be reviewed and be used, if possible, to minimize costs and simplify the regulatory process. For example, a simple local code enacted by a municipal or county health department for regular inspection and pumping might be adequate to significantly reduce onsite system failures in an area. Another example is that existing provisions for ground-water, septage, or general improvement districts could be used to establish a complete management program (Shephard, 1996).

If, however, existing legal authority is insufficient for implementing management responsibilities, state laws could be modified to extend the powers of relevant organizations (e.g., those that already manage centralized wastewater systems or other utilities) to cover the management of decentralized systems, to allow access to private property, or to create new management structures with necessary powers.

Some states or communities have developed or adopted model ordinances or legal agreements, such as the state of Iowa and the community of Kueka Lake, NY (see Appendix E). Examples include entering into service agreements with homeowners for system maintenance (conducted by either a local agency or a private contractor); obtaining property easements for inspections of decentralized systems; and establishing clear public/private ownership, inspection, operation, maintenance, and financial assurance responsibilities for cluster systems. Some cases may require special legislation that authorizes the creation of new entities (such as management districts) with explicit responsibilities for managing decentralized systems (see "Structure of the Management Program" below). Other states should use the model legislation to measure their current legislation against and make adjustments as needed.

The best way to clarify legislative authority is to consolidate programs for centralized and decentralized wastewater systems (e.g., in the state environmental protection agency or state health agency). Authority for specific management functions could then be delegated as appropriate to regional and local agencies. Such consolidation would allow for a comprehensive analysis and equitable appraisal of wastewater needs and how water quality goals could be best met. In addition, consolidating programs on the state and local levels fosters accountability and management program coordination for decentralized systems, which have heretofore not enjoyed much of either.

<u>State and Local Codes Stifle Consideration of Decentralized Systems</u> - State and local regulatory codes often prohibit or restrict the use of alternative onsite systems. These codes require the presence of a certain type of soil in order to build. Several factors influence the development of these codes, including inadequate performance data on alternatives, system complexity, and (most of all) lack of trained staff.

In addition, some communities have restricted decentralized wastewater systems to conventional onsite systems with large lot requirements (e.g., 2 to 5 acres) as a way to control increasing development densities and "maintain the character" of a community. These two subjects (onsite system requirements and land use) should be kept separate; land use control should be performed by zoning agencies, not public health agencies. Without the technical or financial resources to evaluate alternatives or provide necessary management, state and local governments rely on conventional septic tank/leach field systems and codify inflexible, overly conservative specifications that allow only passive, seemingly "maintenance-free" designs (Shephard, 1996). This approach continues to delay the need to address the real problem, which is the lack of a comprehensive management program for both conventional and alternative systems that would ensure their proper siting, design, construction, operation, maintenance, and monitoring. With such management, systems could be assessed and selected according to their ability to meet regional and local performance standards and their suitability for site-specific conditions.

Obtaining case-by-case variances from these restrictive regulatory codes is usually a cumbersome and expensive process. When a failing onsite septic system needs to be retrofitted or replaced quickly to protect public health and the environment, timely approval for an alternative system is unlikely. The result is continued use of an ineffective septic tank/leach field system or an expensive expansion of a centralized system.

Overcoming the Regulatory Barriers. The prescriptive regulatory approach (i.e., with state or local regulations prescribing specific types of systems and design parameters for sites meeting minimum conditions) currently followed in most states generally works only for sites with "ideal" soil and water conditions. In reality, however, most sites have less-than-ideal conditions.

To address varying site conditions, a few communities have established a combination of prescriptive- and performance-based approaches. They allow prescriptive designs for sites where conventional septic-tank/leach field systems can function properly. Performance standards are used for sites with limiting soil and water conditions (e.g., high ground-water tables, low-permeability soils, inadequate soil depth), for environmentally sensitive areas (e.g., coastal bays), in locations experiencing rapid development, and in areas where regional pollution problems already exist.

Some changes in the regulatory approval process that facilitate the use of decentralized systems have occurred or are underway. For example, a few state or local codes (e.g., in Kentucky, North Carolina and West Virginia) now include provisions allowing specific types of alternative systems, such as mounds or sand filters (although their use may be allowed only under certain conditions). A few states are also setting performance standards that would allow designers to select any type of system, as long as it is proven to meet the standards. These standards should specify the quality of the effluent discharged to the groundwater for all types of decentralized systems.

It should be noted, however, that some states attempting to set performance standards have been sued by involved parties who view the performance standards (which are equivalent to discharge standards) for new decentralized systems as too stringent. State officials and the regulated communities are currently re-evaluating specific standards. The problem has arisen because performance standards are not necessarily equivalent to effluent standards. In the case of surface discharge, where a centralized wastewater system discharges directly to surface water, the performance standards set for the facility are the same as the effluent quality standards. For decentralized systems that discharge to ground water, however, performance standards will be different from final effluent standards. The standard must account for the soil providing additional treatment before the wastewater reaches the ground water, the ground water quality and use, and the point of monitoring.

LACK OF ADEQUATE MANAGEMENT PROGRAMS

Few communities have developed organizational structures for managing decentralized wastewater systems, although such programs are required for centralized wastewater facilities and for other services (e.g., electric, telephone, water, etc.). Instead, state regulations prescribe the specifications and design of decentralized systems, and enforcement of these regulations falls to local agencies, often with limited authority, expertise, and staff. Inconsistent laws and policies have resulted in large, urban centralized wastewater facilities being effectively managed, while small, rural decentralized wastewater systems are frequently unmanaged.

The experience of many communities has shown, however, that to protect ground and surface water, decentralized systems, whether for individual or multiple dwellings, must be managed from site evaluation and design, through the life of the system. For individual dwellings, homeowners are responsible for managing their systems. Inadequate operation and a lack of routine maintenance for these systems have led to system failures and the resulting perception that decentralized systems are less reliable than centralized facilities.

An important objective of a management program for decentralized wastewater systems is to ensure that the systems perform satisfactorily over their service lives. In the past decade, some government officials and private citizens have begun to address the problem of failing septic systems in the context of water quality protection, rather than merely as part of private real estate transactions. This shift in perspective reinforces the need for communities to develop comprehensive management programs for decentralized systems.

The incentives for establishing proactive management programs for decentralized wastewater systems include better onsite system performance and environmental protection, extended life of the system, significant cost savings, planning flexibility, assistance for individual homeowners and developers in meeting requirements, and economic benefits accruing from the use of local contractors (Shephard, 1996).

Figure 2 depicts the typical functions of a wastewater management program, which include system planning, legal and financial needs and responsibilities, program coordination, supervision, of installation, operation and maintenance requirements, public participation and education, inspection schedules and monitoring programs. The planning process for wastewater management is described in Appendix B.

Generally, operation and maintenance requirements for decentralized systems are less complex, and less costly, than operation and maintenance requirements for centralized systems.

Overcoming the Lack of Management Barriers - Management programs should be developed on state, regional, or local levels, as appropriate, to ensure that decentralized wastewater systems are sited, designed, installed, operated, and maintained properly and that they continue to meet public health and water quality performance standards.

<u>Structure of the Management Program: Selecting a Management Agency</u> - The structure of a management program depends on the functions to be performed and the resources of the community. The institutional structure should include mechanisms for proposing and enforcing regulations, performing system inspections and maintenance, and monitoring program performance.

Many small communities have unpaid or part-time officials with no technical knowledge in wastewater management and minimal experience working with other levels of government. Therefore, the success or failure of a management program for decentralized wastewater systems may depend significantly on the choice of a management agency. Once a community defines specific functions needed to support system operation, it has to determine whether existing

Identify specific management agency (i.e. special district, municipal authority, municipal government, county agencies, regional agencies, State agencies, Federal agencies, private organizations, and other groups) and indicate responsibilities of each agency

								Comments
Planning/Administration								
Plan preparation								
Plan review coordination								
Research and development								
Office and staff management								
Site Evaluation								
Guidelines and criteria								
Evaluation certification								
Site suitability analysis								
System Design								
Standards and criteria								
Designer certification								
System design								
Design review								
Permit issuance								
Installation								
Construction supervision								
Installer certification								
Record-keeping								
Permit issuance								
Operation and Maintenance								
Procedures and regulations								
Operator/inspector certification								
Routine inspections								
Emergency inspections								
System repair/replacement								
Repair supervision								
Performance certification								
System ownership								
Residuals Disposal								
Disposal regulations								
Hauler certification								
Record-keeping								
Equipment inspections								
Facility inspections								
Facility operation								
Financing								
Secure funding								
Set charges								
Collect charges								
Monitoring								
Reporting system								
Sampling								
Public Education								
Develop methods								
Disseminate information								
Respond to complaints								

Figure 2. Management Program Functions for Decentralized Wastewater Systems

organizations have the statutory authority and resources to carry out these functions. If existing institutions lack certain legal powers, legislative modifications may be necessary (see "Regulatory Barriers" above).

Several types of management arrangements are possible, which may involve existing local agencies, private organizations, or a combination of agencies and organizations, as described in Appendix C. In some cases, such as where wastewater management crosses jurisdictional boundaries, coordinated planning and sharing of natural, financial, and human resources may be necessary, possibly through inter-jurisdictional agreements. Existing or planned water protection programs may be a logical place to incorporate wastewater management programs. Different types of entities can provide management services including local government, private industry, and in some rural areas, management by rural electric cooperatives is being considered (see Appendix F).

Financing the Management Program - Effective management will increase the cost of decentralized wastewater systems, which currently have little, inadequate, or no management in many areas. A variety of financing options commonly used by utilities and other service providers may be adapted to decentralized systems; however, not all management entities have the legal authority to implement each option. The management entity selected may determine the type of financing available (i.e., whether the program will be eligible for federal or state grants; whether taxing is an option; or whether user fees can be collected).

Commonly used financing mechanisms applicable to wastewater management systems include:

- User fees
- Service fees
- Property taxes
- Punitive fees
- Permit fees
- Connection fees
- Special tax assessments
- Federal, state, or private grants or loans
- License fees

Some states and communities are also using creative funding mechanisms for water quality protection such as tobacco taxes, lottery revenues or license plate programs that could be used to partially fund onsite programs, especially retrofitting existing systems.

The issue of eligibility for public funding is discussed below in "Financial Barriers." Management programs for decentralized wastewater systems should, if possible, include a reserve fund to cover management functions and to alleviate some of the liability issues discussed below.

LIABILITY AND ENGINEERING FEE ISSUES

One of the factors that has impeded the acceptance and use of innovative and alternative onsite systems is the potential risk of installing systems that do not perform as anticipated. Due to this risk, regulators have, in many cases, not provided an environment that is conducive to trying out new systems. In some cases, the requirements to install and operate such systems are so administratively or economically burdensome (e.g., redundant systems) that they inhibit new or experimental solutions. As a result, homeowners or developers are often unwilling to accept the liability incurred with alternative systems. In the 1970s and 1980s, EPA's Innovative and Alternative (I&A) Technology Program provided grants of up to 100 percent of the cost for modifying or replacing I/A systems that failed to perform according to their design standards. The I&A program was terminated in 1990, and the current Clean Water State Revolving Fund program contains no similar "modification and replacement" provision. Thus this type of risk insurance no longer exists for the use of decentralized wastewater systems (GAO, 1994). In addition, the issue of liability has been raised in various communities where the use of decentralized cluster systems appears appropriate. Small communities are thus hesitant to choose these systems, despite their apparent advantages.

Engineers also face financial disincentives in designing lower cost decentralized systems since engineers' fees are sometimes based on a percentage of the project cost.

Overcoming the Liability and Fee Barrier. Liability can be addressed within the context of a management program, which can establish ongoing operation and maintenance programs to prevent system failures and mechanisms for covering failures should they occur (e.g., through federal or commercial insurance programs or escrow of a designated portion of system fees). Engineers can also obtain liability insurance. Engineering fees should be based on cost-plus-fixed-fee or lump-sum approaches.

FINANCIAL BARRIERS: PUBLIC GRANT AND LOAN PROGRAMS

Traditionally, EPA grants and loans for the construction of wastewater treatment facilities are available only to public entities. In such cases, if a community wishes to seek such funding, the management agency for decentralized wastewater systems must be a public agency. Private entities such as private contractors, individual homeowners, and homeowners' associations would not be eligible, except under certain provisions of the Clean Water Act that allow federal funds to be used for specific non-point source pollution management programs. Also, states have typically given funding priority to larger communities with more costly wastewater needs over smaller communities with lower-cost needs. Thus smaller communities typically are the last ones to receive wastewater funding assistance and often do not receive these types of funds. In addition, costs for planning purposes and for state review may be higher with alternative systems than for conventional systems. As a result, financially strapped small communities are not able or are reluctant to incur additional costs without financial assistance. At the same time, most small communities are not informed of how to pursue outside funding sources.

Overcoming the Financial Barriers. There are other federal sources of funding for public as well as private entities. The U.S. Department of Agriculture's Rural Utility Service provides funding through the Water and Waste Disposal loan and grant program to public entities, Indian tribes, and organizations operated on a not-for-profit basis, such as an association, cooperative, or private corporation.

Public grant and loan funds for wastewater management should be utilized to a greater extent to manage decentralized wastewater systems where eligible (i.e., the Rural Utilities Service's funding program, EPA's Hardship Grants program, the Clean Water SRF program for nonpoint source control and the CWA section 319 program). Community officials should be educated on the these eligibilities.

Chapter 5

EPA'S ABILITY AND PLANS TO IMPLEMENT DECENTRALIZED TREATMENT SYSTEMS

BACKGROUND

Over the past 20 years, EPA has put considerable resources into helping small communities meet their wastewater needs. This has been accomplished in many ways -- public education, technical assistance, technology transfer, research, demonstrations, and financing. It has been accomplished directly by EPA and state staff, and indirectly through federal funding of the many associations that have come together to support small community needs. Most of the outreach, which includes technical assistance and education has been grouped under the umbrella of EPA's Small Community Outreach and Education Program (SCORE). While EPA personnel have provided some direct technical assistance to small communities, EPA has primarily leveraged state outreach programs through grants and other assistance activities. In addition, assistance to other technical service providers foster activities such as development and distribution of educational materials, telephone consultation, classroom training and field assistance and training. In recent years, EPA's outreach program has been expanded to include special populations such as Native American Tribes and low income "colonias" along the U.S. - Mexico border.

This section responds to both areas raised by the House Appropriations Committee concerning EPA's ability to implement the alternatives within the current statutory and regulatory structure, and EPA's plans for implementation using fiscal year 1997 funds. Described below are ongoing and planned activities and programs conducted by EPA or with EPA assistance, which provide a framework for implementing alternatives such as decentralized treatment systems.

FUNDING

The Construction Grants Program required all but 4 or 5 states to set aside 4 percent of their annual allotments for communities with populations of 3,500 or less to be used only for alternatives to conventional sewage treatments works (Sec.205(h)). Many of these communities have treatment facilities which serve as demonstrations of decentralized technology. Last year, EPA initiated a program to conduct assessments of many innovative technologies funded under the Construction Grants program, and any other new technologies which have been put into use more recently. These assessments will continue over the next several years. As the assessments are completed, the information will be provided to our customers in various formats from technical reports to fact sheets to pamphlets.

Although there is no specific set aside for small communities or alternative systems in the Clean Water State Revolving Fund program (SRF), decentralized technologies are eligible for funding. EPA staff are aware of decentralized systems funded by the SRF around the country. In Pennsylvania, local banks process SRF loans for homeowners which fund onsite systems. Minnesota has developed the Clean Water Partnership Program that has provided funds to Brown, Nicollet and Cottonwood counties to re-loan to homeowners for conventional onsite system replacements. SRF funding has also provided assistance to the Osakis Lake Project to replace failing systems around Osakis Lake. The state of Washington provides SRF loans to local loan funds. These funds in turn provide loans to homeowners and small businesses for the rehabilitation or reconstruction of onsite systems. Ohio, Virginia and West Virginia are developing similar programs.

In an effort to expand the types of projects funded by the SRF, EPA issued the "Clean Water State Revolving Fund Funding Framework" in October 1996. This document was developed in conjunction with state SRF partners to clarify the eligible uses of SRF funds and provide tools to establish relative priorities among water quality projects. States are encouraged to assess water quality problems on a watershed basis and develop integrated priority setting processes. With the expansion of the SRF to cover activities included in EPA approved nonpoint source management plans, onsite treatment projects have a much greater potential for funding by the SRF. EPA plans to sponsor training workshops to further educate the nonpoint source community about the SRF as a potential source of funding for nonpoint source projects (including onsite systems) and facilitate coordination with the state SRF programs. Demonstration grants have also been issued to six states to develop integrated priority setting systems that can be used as models by states.

Recognizing that several federal agencies provide funds for wastewater collection and treatment, EPA is participating in an effort with USDA's Rural Utility Service and HUD to provide funding to communities in a more efficient and less burdensome manner. Improved coordination and cooperation between the Agencies will include:

- Coordinating funding cycles and selection systems on a State-by-State basis,
- Promoting the use of a lead agency for jointly financed projects, where suitable, to receive and review environmental review documents and ensure compliance with Federal cross-cutting legislation, and
- Encouraging the use of a single application on a State-by-State basis to address similar data requirements.

A memorandum outlining this effort, to be signed by the three Agencies, is being prepared. Follow-up actions to implement these improvements will be undertaken in fiscal years 1997 and 1998.

Most recently, EPA issued guidelines for a new $50 million Hardship Grants Program for Rural Communities. To qualify for hardship assistance a grantee must be a rural community with a population of 3,000 or fewer; lack centralized wastewater collection or treatment; have a per capita income less than 80% of the national average; and have an unemployment rate of one percent or more above the national rate. This program is designed to be managed in conjunction with the SRF program to make wastewater treatment more affordable to rural, economically disadvantaged communities. The Hardship Grant funds can be used to plan, design and construct publicly-owned wastewater treatment works and/or provide training programs for sanitarians related to the operation and maintenance of such systems. Although no grants have yet been made to communities, it is expected that many communities receiving hardship grants will have failing septic tanks. Decentralized systems may be viewed as the most economical treatment option for dispersed, rural communities. Examples of technical assistance that may be provided to communities are over-the-shoulder training, educational seminars, and assistance with development of local management districts. States that take advantage of this program can make strides toward eliminating the barriers identified earlier in this response. Financial assistance under this program will be provided to qualifying communities during fiscal years 1997 and 1998.

CWA Section 319 program grants are also available to assist States in implementing approved nonpoint source management programs. Section 319 grants have been used to support numerous projects that relate to decentralized system program implementation and technology demonstrations. Examples of projects that have been funded through Section 319 include: Demonstration of Alternative Onsite Systems; Maintenance of Onsite Constructed Wetlands; Analysis of Onsite Sewage System Impacts on Groundwater Quality; Onsite Septic System Demonstration and Training; Septic System Survey; Septic System Inventory and Inspection Education Program; and Evaluation and Upgrades of Onsite Systems.

OUTREACH, TRAINING AND EDUCATION

In addition to the ongoing outreach efforts conducted by EPA staff, several significant efforts, described below, are underway and will continue, which provide technical assistance to small communities.

Since 1979, EPA has funded the National Small Flows Clearinghouse, at West Virginia University in Morgantown. The Clearinghouse is the national repository and referral service for the transfer of information on decentralized, onsite, alternative collection and small treatment technologies and serves as a model for several other countries which are interested in establishing similar programs. The Clearinghouse services include: (1) a toll-free technical assistance hot line which answers over 3,000 assistance calls per month, (2) product distribution, which involves filling over 1,000 orders monthly for 10,000 publications, articles, reports, and videotapes, (3) publication of two newsletters and a professional journal reaching over 7,000 subscribers, (4) several national computer data bases on small community wastewater technology and regulations, and (5) a site on the World Wide Web. The Clearinghouse has a wealth of information available that can provide state and local regulators with the means to change laws and make technical decisions. Examples include: (a) maintaining a database and summary of all state regulations relating to onsite systems; (b) a recent survey of all health departments in the nation, identifying such information as the number of households served by conventional onsite systems, how many are failing, and what local regulations apply; (c) establishing a database on the testing of various onsite technologies conducted by six states in New England, and will also facilitating communication among the states regarding the testing results. The Clearinghouse services are being used more and more each year.

The Small Towns Environment Program (STEP) was funded several years ago through a grant to Rensselaerville Institute as a grass-roots, self-help program. STEP encourages the use of small alternative wastewater systems and calls for citizens to perform many functions the community would otherwise pay outsiders to do.

EPA also funds an organization based at West Virginia University, the National Environmental Training Center for Small Communities (NETCSC). This center supports environmental trainers nationwide through development and delivery of training curricula and training of trainers. Services also include a toll-free telephone line, quarterly news letter, and a training resource center with computer databases. Several courses have been developed on wastewater topics, including onsite and decentralized treatment. Examples include: "Assessing Wastewater Options for Small Communities", "Basics of Environmental Systems Management", "Onsite Wastewater System Operation and Maintenance", and "Operation of Sand Filters".

Some state organizations have already taken responsibility for onsite training. Presently at least six states have an organization with a center for training personnel associated with installing and regulating onsite wastewater systems (Arizona, Missouri, North Carolina, Rhode Island, Texas and Washington). EPA recently awarded a grant to the NSFC for establishment of a new onsite training center in Vermont.

TECHNOLOGY AND DEMONSTRATIONS

EPA's technology and demonstration programs have fostered and collaborated with others over the past 25 years to provide many of the technical guidance materials available today. Listed below is a summary of work that is currently underway.

- The National Onsite Demonstration Project is a three-phased, $3.5 million program to demonstrate alternative onsite wastewater systems. Funded by EPA through the NSFC, this program includes construction and monitoring of demonstration facilities, community education programs, technology transfer and building the capacity of states to implement appropriate systems. This project started in 1993 and is expected to be completed in the year 2000. Demonstration projects have been started in 12 communities in 10 states.

- EPA is in the process of updating two of its design manuals: "Design Manual for Onsite Systems" and "Design Manual for Constructed Wetlands Wastewater Treatment Systems". The Design Manual for Onsite Wastewater Systems is currently under. development and is expected to be published in 1998. The manual on constructed wetlands will be completed within the next year. A manual on Small Community Technologies was recently updated.

- Several grants have been awarded, in the past two years, under the Environmental Technology Initiative, to design and demonstrate onsite technologies. These projects will be getting underway this year and the results will be made available within a couple of years, when demonstrations are completed.

- A grant to develop a research agenda for the field of onsite wastewater treatment and to begin some targeted research efforts is currently being prepared for award sometime later this year. This grant should help to coordinate research and uncover significant needs that are currently being missed.

- Within EPA, discussions are being held to establish a small community wastewater technology testing and verification program under the Environmental Technology Verification (ETV) program. ETV is a new program to verify the performance of innovative technical solutions to problems that threaten human health or the environment. This would allow manufacturers of onsite system technologies to obtain independent testing of their technologies. It would also allow state and local authorities to know that the technologies will meet acceptable standards.

- EPA's ground water program in coöperation with the wastewater program is currently developing a guidance manual for large septic systems; a type of decentralized treatment. This guidance is also under final quality review at this time and will be published by the end of the year.

- Outside EPA, and without EPA funds several demonstrations of technologies are also being conducted. Five onsite demonstration projects are being initiated this year by the Pennsylvania State Rural Electric Cooperative Association. The State of North Carolina has numerous demonstration activities focused on decentralized and onsite treatment. EPA will utilize these demonstrations in assessing new technologies. Also the NSFC is establishing a database which will serve as a repository of information on all projects demonstrating onsite wastewater technology.

PROGRAM DEVELOPMENT

EPA plans to collaborate with other federal agencies to develop guidance to assist communities to implement management systems. One such guidance document has been developed titled, "On-site Wastewater Management and Protection of Sensitive Receiving Water Systems: Planning for Opportunities." EPA also plans to promote the development of decentralized management programs which are based on performance goals. Under this effort, EPA plans to provide analytical tools and guidance to assist state and local governments in revising and updating decentralized system programs.

The Office of Water has promoted the watershed concept over the past several years to move toward the place-driven approach which will give holistic attention to ecosystems. This approach places the focus of watershed pollution abatement needs on the clean-up activities which will allow watersheds to meet their designated uses. Some watershed analyses have identified onsite systems as sources of pollution.

EPA is collaborating with other federal, state and local agencies as well as private partners, to achieve the ultimate goal of a healthy ecosystem in these watersheds. Many of the tools needed to accomplish this work already exist, although additional tools will be developed. They will have to be applied by the state and local authorities to solve the pollution problems that remain.

Once completed, the Office of Water will transmit this response to EPA Regional offices, State agencies, the National Rural Electric Cooperative Association, and other stakeholders and encourage them to take follow-up actions, as appropriate, to promote improved management and operation of decentralized wastewater treatment systems.

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Appendix A

Definition of Terms and Descriptions of Wastewater Systems

DEFINITIONS

Activated Sludge: A wastewater treatment process that uses suspended microorganisms to digest the organic contents of wastewater. (see "Suspended Growth Systems' in the Description of Wastewater Systems" section below)

Alternative onsite system: An onsit treatment system other than a conventional septic tank and leach field design. Alternative systems are used to accommodate a variety of site conditions (e.g., high ground water, low-permeability soil) and/or to provide additional treatment. Examples of alternative systems include alternative collection sewers, sand mounds, sand filters, anaerobic filters, disinfection systems, and cluster systems, among others, as described in "Descriptions of Wastewater Systems".

Alternative Sewers: Low-cost wastewater collection systems for small communities and/or areas with difficult topography or high ground water or bedrock. Alternative sewers are smaller in size than conventional sewers and are installed at shallower depth, providing a more cost-effective method of wastewater collection. The three main classes of alternative sewers are pressure sewers, small diameter gravity sewers, and vacuum sewers.

Black Water: Wastewater from the toilet, which contains most of the nitrogen in sewage.

BOD: Biochemical Oxygen Demand (BOD) is the measure of the amount of oxygen required by bacteria for stabilizing material that can be decomposed under aerobic conditions. BOD is a commonly used determinant of the organic strength of a waste.

Centralized System: A collection and treatment system containing collection sewers and a centralized treatment facility. Centralized systems are used to collect and treat large volumes of wastewater. The collection system typically requires large-diameter deep pipes, major excavation, and frequent manhole access. At the treatment facility, the wastewater is treated to standards required for discharge to a surface water body. The large amounts of biosolids (sludge) generated in treatment are treated and either land applied, placed on a surface disposal site, or incinerated.

Class V Well: A shallow waste disposal well, stormwater and agriculture drainage system, or other device, including a large domestic onsite wastewater system, that is used to release fluids above or into underground sources of drinking water. EPA permits these wells to inject wastes provided they meet certain requirements and do not endanger underground sources of drinking water.

Cluster System: A decentralized wastewater collection and treatment system where two or more dwellings, but less than an entire community, is served. The wastewater from several homes often is pretreated onsite by individual septic tanks before being transported through alternative sewers to an off-site nearby treatment unit that is relatively simple to operate and maintain than centralized systems.

Conventional Onsite System: A conventional onsite system includes a septic tank and a leach field.

Decentralized System: An onsite or cluster wastewater system that is used to treat and dispose of relatively small volumes of wastewater, generally from dwellings and businesses that are located relatively close together. Onsite and cluster systems are also commonly used in combination.

Effluent: Partially or fully treated wastewater flowing from a treatment unit or facility.

Eutrophication: A process by which nutrient-rich surface water or ground water contributes to stagnant, oxygen-poor surface-water environments which may be detrimental to aquatic life.

Facultative Pond: A lagoon that is sufficiently deep (i.e., 5 to 6 feet) where organic solids settle to the bottom as sludge and decay anaerobically; a liquid layer forms above the sludge where facultative and aerobic bacteria oxidize the incoming organics and products of anaerobic sludge decomposition.

Fecal Coliform Bacteria: Common, harmless forms of bacteria that are normal constituents of human intestines and found in human waste and in wastewater. Fecal coliform bacteria counts are used as an indicator of presence of pathogenic microbes.

Gray Water: Non-toilet household wastewater (e.g., from sinks, showers, etc.).

Leaching Field: See "Subsurface Soil Absorption Field".

Management of Decentralized Systems: The centralized management and monitoring of onsite or cluster wastewater systems, including, but not limited to, planning, construction, operation, maintenance, and financing programs.

National Pollutant Discharge Elimination System (NPDES): A regulatory system that requires wastewater treatment systems discharging into surface waters to obtain a permit from the EPA which specifies effluent quality.

Nonpoint Source Discharges: Relatively diffuse contamination originating from many small sources whose locations may be poorly defined. Onsite wastewater systems are one type of Nonpoint source discharge.

Onsite System: A natural system or mechanical device used to collect, treat, and discharge or reclaim wastewater from an individual dwelling without the use of community-wide sewers or a centralized treatment facility. A conventional onsite system includes a septic tank and a leach field. Other alternative types of onsite systems include at-grade systems, mound systems, sand filters and small aerobic units. These and other types of onsite systems are described in the "Description of Wastewater Systems" section.

Package Plant: Prefabricated treatment units that can serve apartment buildings, condominiums, office complexes, and up to a few hundred homes. Package plants generally are used as cluster systems, but can also be used in an onsite wastewater treatment train. They are usually of the activated sludge or trickling filter type, and require skilled maintenance programs.

Point Source Discharges: Contamination from discrete locations, such as a centralized wastewater treatment facility or a factory.

Pressure Sewers: An alternative wastewater collection system in which household wastewater is pretreated by a septic tank or grinder and pumped through small plastic sewer pipes buried at shallow depths to either a conventional gravity sewer or a treatment system. Pressure sewers are used in areas with high groundwater or bedrock, low population density, or unfavorable terrain for gravity sewer collection. They require smaller pipes and less excavation than conventional sewers. Two types of pressure sewers include:

Septic Tank Effluent Pump (STEP). A submersible pump located either in a separate chamber within a septic tank or in a pumping chamber outside the tank pumps the settled liquid through the collector main. Because the wastewater is treated in a septic tank, the treatment facility may be smaller and simpler than would otherwise be needed.

Grinder Pump. Household wastes flow by gravity directly into a prefabricated chamber located either in the basement of a house or outside the foundation wall. The chamber contains a pumping unit with grinder blades that shred the solids in the wastewater to a size that can pass through the small-diameter pressure sewers.

Pumping Stations: A pumping facility is used to lift wastewater where topography is too flat or hilly to permit natural gravity flow to treatment facility.

Receiving Water: Streams (i.e., surface water bodies) into which treated wastewater is discharged.

Residuals: The by-products of wastewater treatment processes, including sludge and septage.

Secondary Treatment: Typical effluent quality achieved by a conventional centralized treatment facility, typically defined as 85% reduction of influent BOD and TSS or 30 mg/l or both; which ever is least.

Septage: The solid and semi-solid material resulting from onsite wastewater pretreatment in a septic tank, which must be pumped, hauled, treated, and disposed of properly.

Sludge: The primarily organic solid or semi-solid product of wastewater treatment processes. The term sewage sludge is generally used to describe residuals from centralized wastewater treatment, while the term septage is used to describe the residuals from septic tanks.

Small-Diameter Gravity Sewers: An alternative wastewater collection system consisting of small-diameter collection pipes (e.g., between three and six inches) that transport liquid from a septic tank to a treatment unit, utilizing differences in elevation between upstream connections and the downstream terminus to achieve gravity flow.

Subsurface Soil Absorption Field: A subsurface land area with relatively permeable soil designed to receive pretreated wastewater from a septic tank or intermediate treatment unit (e.g., sand filter). The soil further treats the wastewater by filtration, sorption, and microbiological degradation before the water is discharged to ground water.

Trickling Filter: A fixed-film (see "Fixed Growth Systems" in "Description" section below) biological wastewater treatment process used for aerobic treatment and nitrification.

Total Suspended Solids (TSS): A measure of the amount of suspended solids found in wastewater effluent.

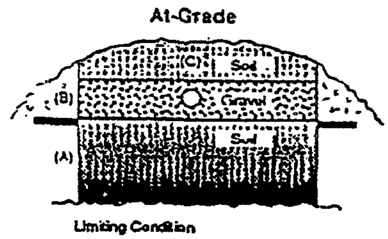
Vacuum Sewers: An alternative wastewater collection system that uses vacuum to convey household wastewater from each connection to a vacuum station which includes a collection tank and vaccum pumps. Wastewater is then pumped to a treatment facility or conventional sewer interceptor.

Appendix A (continued)

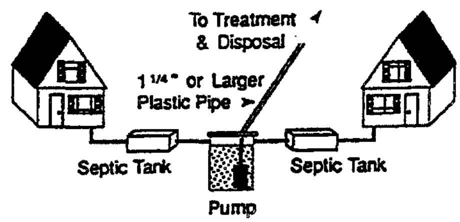
DESCRIPTIONS OF WASTEWATER SYSTEMS

Anaerobic Filters: Anaerobic filters are used as part of a treatment train designed to minimize nitrate concentration in areas where discharge of nitrates to surface water or ground water is a concern. Anaerobic filters convert nitrate (NO_3) to gaseous forms of nitrogen (N_2, N_2O, NO). The key design consideration for anaerobic filters is to ensure that the carbon-to-nitrogen ratio is sufficient for denitrification. Good performance can be obtained by treating septic tank effluent with a nitrifying (usually sand) filter before the anaerobic filter.

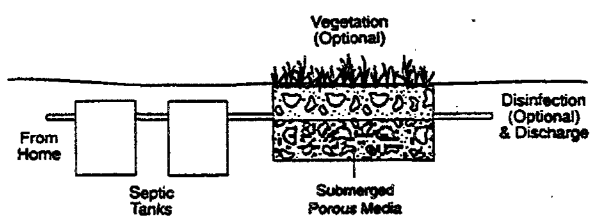
At-Grade Soil Absorption Systems: At-grade soil absorption systems are similar to the subsurface soil absorption systems, but bedding material (usually gravel) is placed at the ground surface rather than below ground and is covered with soil fill material. At-grade systems are used in areas with relatively high ground-water tables or shallow bedrock.



Cluster Systems: Decentralized wastewater collection and treatment systems serving two or more dwellings, but less than an entire community. Sometimes, the wastewater from several homes is pretreated onsite by individual septic tanks before being transported through alternative sewers to an off-site, nearby treatment unit that is relatively small compared to centralized systems.



Constructed Wetlands: Constructed wetlands are engineered systems designed to optimize the physical, chemical, and biological processes of natural wetlands for reducing BOD and TSS concentrations in wastewater. Wastewater from a septic tank flows through a pipe into the wetland, where the wastewater is evenly distributed across the wetland inlet. Sedimentation of solids with the media substrate occurs. Constructed wetlands are reliable for BOD and TSS removal, and may contribute to nutrient removal when used after a nitrifying unit process.



Disinfection Systems: Disinfection refers to the destruction of disease-causing organisms called pathogens (e.g., bacteria, viruses) by the application of chemical or physical agents. Disinfection may be necessary where other types of treatment are inadequate to reduce pathogen levels to the required regulatory standards for surface discharge. The most common types of disinfection for decentralized systems are:

Chlorination Systems. Chlorination occurs by mixing/diffusing liquid or solid chlorine forms with wastewater. Chlorination is considered to be the most practical disinfection method for onsite wastewater treatment because it is reliable, inexpensive, and easy to use; however, dechlorination may be needed to prevent the dispersal of residuals that may be harmful to aquatic life.

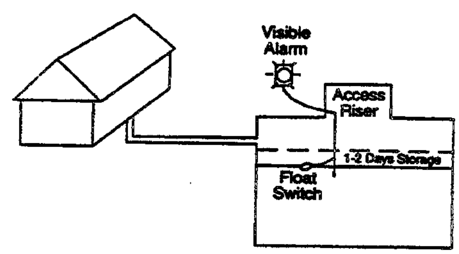
Ultraviolet Disinfection. In an ultraviolet treatment system, high intensity lamps are submerged in wastewater or the lamps surround tubes that carry wastewater. Disinfection occurs when the ultraviolet light damages the genetic material of the bacterial or viral cell walls so that replication can no longer occur. Care must be taken to keep the surface of the lamps clean because surface deposits can shield the bacteria from the radiation, thus reducing the performance of the system. Ultraviolet radiation is a highly effective technique especially attractive in cluster systems where the effluent cannot include any residuals or where there are overriding concerns with safety.

Effluent Distribution Systems: Effluent distribution systems are essential components of subsurface wastewater treatment systems. These systems deliver wastewater to soil infiltrative surfaces either by gravity or by pressure distribution.

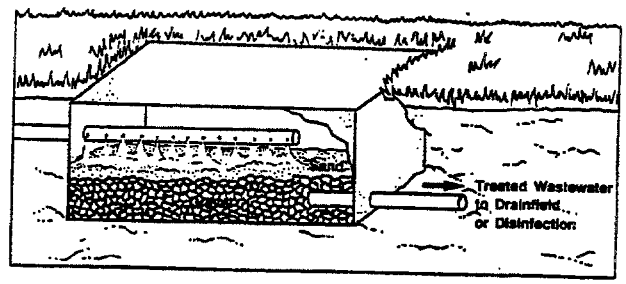
Pressure distribution. Pressure dosing systems distribute water over more infiltrative surface and provide a resting period between doses that increases the life and performance of the leach field. Dosing siphous or pumps provide the pressure; the latter requires additional maintenance demands.

Fixed Growth Systems: In fixed growth systems, aerobic microorganisms attach and grow on an inert media. Wastewater flows across a slime layer created by the attached microorganisms, which extract soluble organic matter from the wastewater as a source of carbon and energy.

Holding Tank: A large storage tank for wastewater or septage. An alarm on the tank signals when the tank is full and the contents need to be pumped and properly disposed.



Intermittent Sand Filters (ISF): An intermittent sand filter consists of sand media with a relatively uniform particle-size distribution above a gravel layer. An ISF reduces BOD and TSS concentrations to 10 mg/L or less. Wastewater passes through the filter and drains from the gravel to the collector. Uniform distribution of influent is very important to filter performance. Influent is dosed to the surface 4 to 24 times per day, with best performance from higher numbers of smaller doeses. The sand filter material may be left exposed or covered with removable covers. A septic tank (or other pretreatment system) is required to remove settleable solids and grease, which can clog the sand. Covers are used in cold climates. If sand filter material is left exposed, it must be checked regularly for litter, vegetation growing on the surface. It may require raking perodically. An uncovered system also is susceptible to potential odor problems. Less frequently, the sand may require removal and replacement of the top layer.



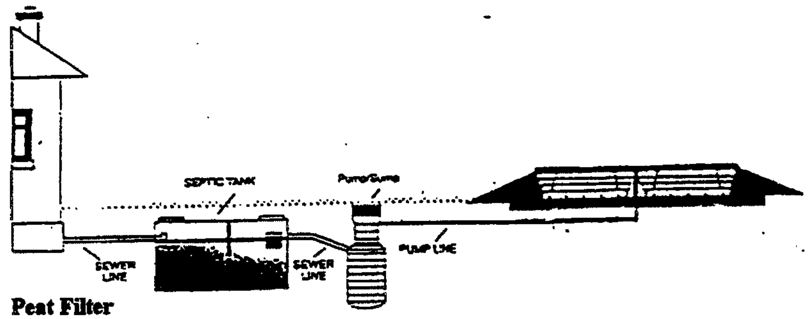
Nitrogen Removal Systems: Several types of treatment processes are capable of removing nitrogen in wastewater. Nitrogen removal systems are used in onsite treatment trains to ensure protection of ground water as well as coastal waters recharged by ground water. Biological nitrogen removal requires aerobic conditions to first nitrify the wastewater, then anaerobic conditions to denitrify nitrate-nitrogen to nitrogen gas. The successful removal of nitrogen from wastewater requires that environments conducive to nitrification and denitrification be induced and positioned properly. Three types of nitrogen removal systems are described below:

Separation of Black Water and Gray Water. Black water (toilet water) can be segregated from other sources of household wastewater (gray water) for separate treatment and disposal. A separate plumbing system within a house is required. Black water, which contains 80% or more of the nitrogen in household wastewater, can be discharged directly to a holding tank; the remaining gray water is discharged to a septic tank/soil absorption system.

Nitrification/Denitrification Trickling Filter Plant. Septic tank effluent is recycled by a pump toa low-loaded, plastic-media trickling filter for aerobic treatment; and nitrification can occur. Filtrate from the trickling filter returns to the lower anaerobic septic tank effluent, providing an environment conducive to biological denitrification.

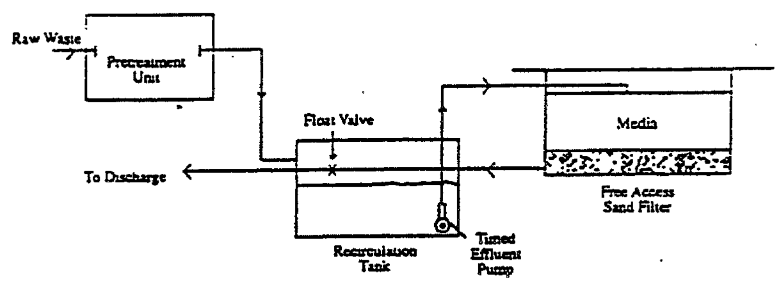
Recirculating Sand Filters. Recirculating sand filters also can provide consistent nitrogen removal (See "Recirculating Sand Filter" below).

Non-Sand Filters: Non-sand filters function similarly to sand filters but use materials other than sand as the filter medium, including natural media such as peat and bottom ash, and synthetic media such as expanded polyurethane foam and honeycombed plastic to reduce levels of TSS, BOD, and fecal coliforms. Most non-sand filter media are packaged in units or placed in enclosures and use pressure dosing to distribute the effluent in the filter.

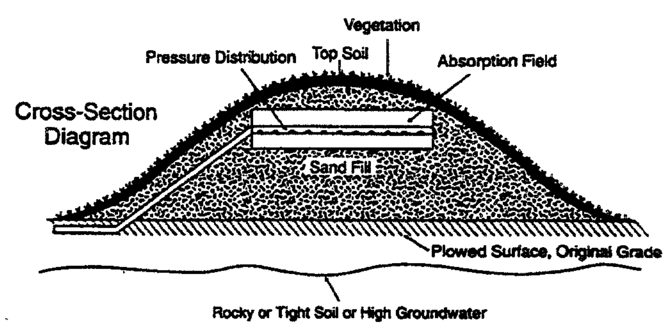


Peat Filter

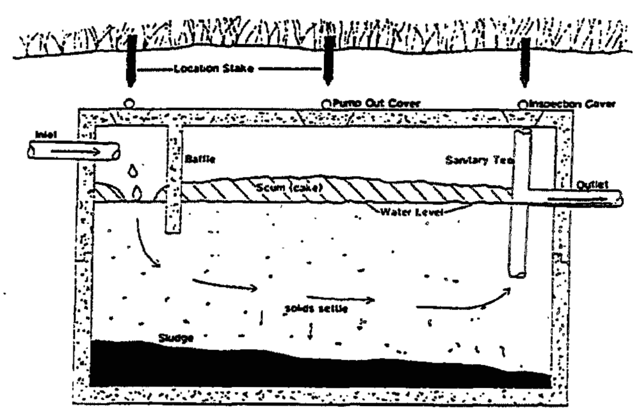
Recirculating Sand Filters (RSF):
A recirculating sand filter uses relatively coarse sand or gravel media for filtration of wastewater. The wastewater is dosed from a recirculating tank, which receives septic tank effluent and returned filtrate. A portion of the filtrate is diverted for disposal during each dose. RSFs are suitable in areas too small for conventional soil absorption systems or with shallow depths to groundwater or bedrock. RSFs can be used for reducing TSS, BOD, fecal coliform, and nitrogen. RSFs are reliable, requiring little maintenance in comparison to activated sludge systems.



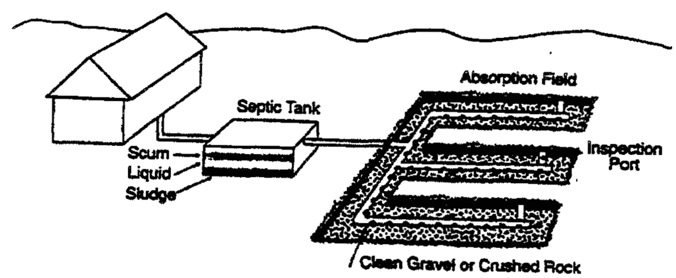
Sand Mounds: Sand mounds are used when soil depth is too shallow for a conventional septic tank and leach field system. The sand mound filters septic tank effluent before it reaches the natural soil. Sand fill is placed above the ground surface, and a pipe distribution system and pressure dosing is used to distribute the effluent. A septic tank or other pretreatment is required to remove settleable solids and grease.



Septic Tank: A buried tank designed and constructed to receive and pretreat wastewater from individual homes by separating settleable and floatable solids from the wsteater. Grease and other light materials, collectively called scum, float to the top. Gases are normally vented through the building's sewer pipe. An outlet blocked off from the scum layer feeds effluent to a subsurface soil absorption area or an intermediate treatment unit.

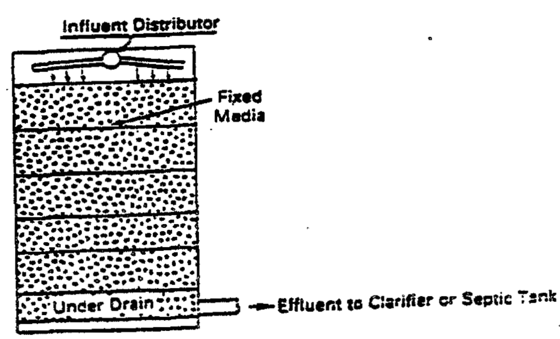


Subsurface Soil Absorption Systems: A typical soil absorption system consists of perforated piping and gravel in a field or trench, although gravelless systems can also be used. Soil absorption systems are normally placed at relatively shallow depths (e.g., <2 ft). Excellent TSS, BOD, phosphorus, and pathogen removal is provided in the unsaturated soil which surrounds the infiltrative surfaces. If properly sited, designed, constructed, and maintained, subsurface soil absorption systems are very reliable and can be expected to function for many years.



Suspended Growth Systems: Suspended growth treatment systems are variations of the activated sludge process in which microorganisms are suspended in an aerated reactor by mixing. Oxygen is supplied to oxidize organic carbon and, possibly, nitrogen compounds. Effluent is discharged either to surface water or subsurface systems . Suspended growth systems can be engineered as package plants to serve clustered residential housing, commercial establishments, or small communities with relatively small flows.

Trickling Filters: Used to reduce BOD, pathogens, and nitrogen levels, trickling filters are composed of a bed of porous material (rocks, slag, plastic media, or any other medium with a high surface area and high on permeability). Wastewater is first distributed over the surface of the media where it flows downward as a thin film over the media surface for aerobic treatment and is then collected at the bottom through an underdrain system. The effluent is then settled by gravity to remove biological solids prior to being discharged.



Appendix B

The Wastewater Planning Process

Appendix B The Wastewater Planning Process

The wastewater planning process involves coordinating a variety of technical and institutional factors, including engineering, environmental, legislative, public education, socioeconomic, and administrative considerations, as shown in Figure B-1. The goal of the wastewater planning process is to develop a comprehensive plan to guide the community in the selection, siting, construction, operation, maintenance, and financing of wastewater systems that address the wastewater needs of the community. A key part of the planning process is a systematic evaluation of the financial and regulatory feasibility of all practical centralized and decentralized engineering alternatives. The steps in a wastewater planning process typically include (Arenovski and Shephard, 1996):

- Needs assessment—establishing an overall community profile, including current and future needs and issues, and identifying areas of concern where existing wastewater facilities are inadequate or problems might occur in the future.

- Development and screening of alternatives—examining which technology, or combination of technologies, will best address the concerns the community faces. The alternatives to consider include expanding or upgrading existing systems or improving their operation and maintenance, as well as installing new systems.

- Evaluation of community-wide plans—comparing the feasibility and cost-effectiveness of a small number of viable plans, and comparing each to a "baseline alternative" of maximizing the use of existing facilities.

In many communities, results of wastewater planning efforts will indicate that the best option is choosing several alternatives—that is, decentralized onsite wastewater systems in one part of the community, decentralized cluster systems in other sections, and a centralized facility in another part of town. This type of integrated approach reinforces land use planning; it also emphasizes the need for adequate management of decentralized systems, and for centralized and decentralized systems to be managed together by a central oversight agency (Shephard, 1996).

Comprehensive Planning

Wastewater system options are best selected in conjunction with broader, comprehensive community planning efforts to ensure that overall community goals are being met, such as environmental protection and land use goals. The planning process includes an analysis of the physical, social, economic, cultural, and environmental characteristics of the planning area. For example, if a watershed protection program already exists in a region to protect sensitive environmental areas, more advanced wastewater treatment (e.g., disinfection or nutrient removal) might be included as part of the watershed program, whether as part of a centralized or decentralized wastewater system (note that a decentralized system would allow the flexibility of installing advanced treatment only for those dwellings in close proximity to the sensitive areas). Similarly, if local land-use planning efforts include maintaining open space and conservation/woodland areas, wastewater management choices can complement such efforts (e.g., by encouraging cluster developments serviced by cluster wastewater systems).

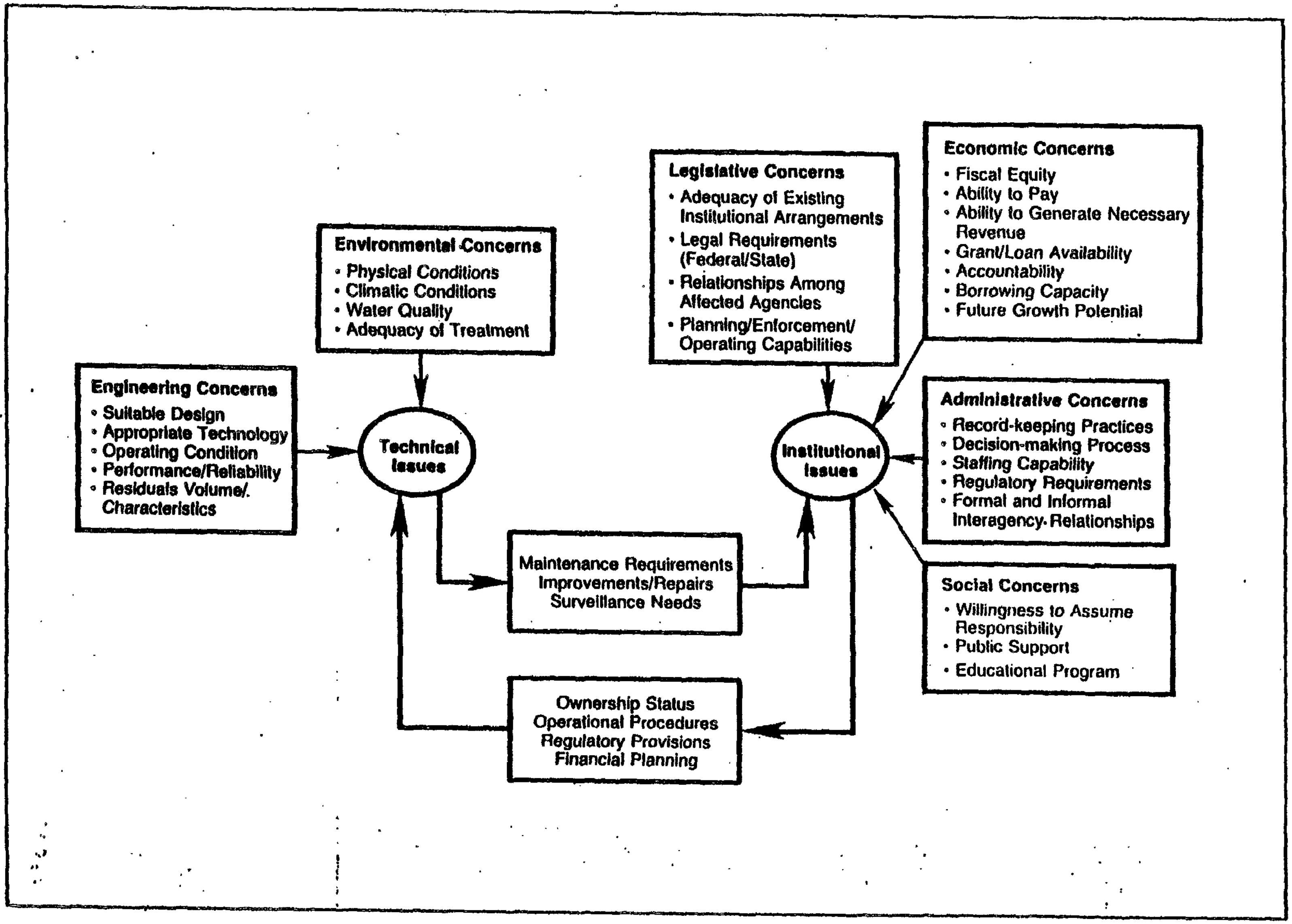


Figure B-1. Technical and institutional factors in decentralized wastewater systems management planning.

Appendix C

Types of Management Structures for Decentralized Wastewater Systems

Appendix C Types of Management Structures for Decentralized Wastewater Systems

Table C-1. Management Structures

Management Entity	State Agency	County	Municipality	Special District	Improvement District	Public Authority	Public Nonprofit Corp.	Private Nonprofit Corp.	Private For Profit Corp.
Description	Environmental protection agencies, health departments, and public utilities	Most basic political subdivision in a state. Comprised of incorp. munic. and unincorp. areas.	Cities, towns, villages, and townships.	Performs funct-ions prescribed by state-enabling legislation. Provides single or multiple services.	Device used by counties/ munic. to provide services to local gov. jurisdictions.	Authorized to administer a revenue-producing public enterprise. Similar to a special district.	Provides water or wastewater services on behalf of local governments.	Established by the users of a facility to assist in facility financing and operation.	Can design, operate, or maintain sewerage facilities.
Service Area	Program enforcement can be handled on a regional basis.	Provides service throughout its juris. and to defined areas via improvement districts.	Provides service throughout its juris. and to defined areas via improve-ment districts.	Flexible	One or more as part of a single jurisdiction.	Flexible	Flexible (single community, group of communities, or statewide)	Can include subdivisions, small communities, and rural areas	Flexible (single homeowner to small community)
Governing Body	State legislature. Agencies report to the governor, legislature, or to a board of directors	Includes elected (princ. legislative branch) county board com-mission, council-administrator, council-elected executive.	Mayor-council, commission, and council-manager.	Board of directors (elected, appointed, or existing agency members)	Governing body of the creating unit of government.	Board of directors (elected or members of local government)	Usually municipal or state officials.	Board of directors elected by stockholders or a property owners association.	Private utility has stock-holders or investors. Public utility commission (PUC) has jurisdiction.
Responsibilities	Code enforcement of wastewater design, install-ation, and operation standards; and technical and financial assistance.	Coordinates munic. in its juris.; provides special services on contract basis; serves as a fiscal agent for other local units of government.	Provides a wide range of services.	All wastewater management functions, similar to local government. State defines function and scope.	State statutes define extent of authority. Usually applied to finance public service improvements.	Used primarily for financing capabilities.	Serves as financing mechanism. Can provide technical assistance to small communities.	Provides financing and operational functions.	Active and flexible role to play in managing small wastewater systems.

Table C-1 (continued)

Management Entity	State Agency	County	Municipality	Special District
Financing Capabilities	Provides financial support through federal grants and state revenues.	Charges for sewerage sources and finance construction through taxation, general funds, special assess-ments, bonds, and permit fees.	Has a broad range of fiscal powers (similar to counties).	Local taxation, service charges, special assess-ments, grants, loans, bonds, and permit fees.
Advantages	Regulatory and financial advantages over local government. State enforce-ment can insulate from local political pressure. Can administer training/cert. programs.	Can interact with states and local governments on many issues. Often seen as administrative arms of the state. Provide efficient resource base for providing public services.	Can better react to local perception and attitude.	Flexible. Renders equitable services (only those receiving services pay for them). Simple, independent forms of government.
Disadvantages	Program organizations differ. (Difficult to implement methods from one state in another. Can become distanced from local governments.	Sometimes not willing to provide specialized public services to a defined service area. Community debt limits could be restrictive.	Might lack admin. capa-bilities, staff, or willingness to design, install, operate, and/or regulate a facility. Financial capabilities might be limited.	Can promote proliferation of local govern-ment and duplication and fragmentation of public services. Fiscal problem could result from overuse.

Management Entity	Improvement District	Public Authority	Public Nonprofit Corp.	Private Nonprofit Corp.	Private For Profit Corp.
Financing Capabilities	Can apply special property assessments, user charges, other fees. Can sell bonds.	Can use revenue bonds, user charges, and connection fees.	User charges and services fees and sales of stocks and tax-exempt bonds. Can accept some Federal grants and loans.	Eligible for Federal grants and loans.	User charges. The PUC can influence the service rates charged.
Advantages	Can extend public services without major expenditures. People in the benefitted area usually favor the improvement.	Good when local governments are not able to provide public service because of financial, administrative, or political problems. Has a certain degree of autonomy.	Offers flexibility in establishing management facilities and financing facilities by state and local governments. Financing method doe not affect local debt limitations.	Provides public services where local govern-ments are unwilling or unable.	Frees the local public sector from providing these services. Competition between firms will help maintain quality while keeping costs down.
Disadvantages	Contributes to fragmentation of local government services. Can result in administrative delays.	Financing ability is limited to revenue bonds. Thus, local government must support the debt incurred by the public authority.	Local governments might be reluctant to apply this concept.	Services could be of poor quality or could be terminated.	Threat that the company could go out of business. Private corporations are usually not qualified for federal and state grant and loan programs.

Source: Ciotoli and Wiswall, 1982.

In addition to the types of management structures described above, two additional approaches to managing decentralized wastewater systems include public/private partnerships and management districts, as describe below.

Public/Private Partnerships. It is sometimes difficult to determine which parties are responsible for the various decentralized system management functions because of the split responsibility between the public and private sector. Several options exist for public/private partnerships in the management of decentralized systems. Systems can be privately owned and managed under a permit system, privately owned and publicly managed, or publicly owned and managed. In the first option, the resident must comply with the regulations and pays all costs for maintenance, pumping, and if necessary, rehabilitation. In the second option, the resident pays user charges to the local district which performs the necessary maintenance (this does not cover rehabilitation). The final option involves the public organization providing wastewater services for all households and collecting user charges to pay for the service; all construction, operation, and maintenance tasks are performed by the public agency, or firms under contract to it.

Wastewater Management District. When a government agency or public authority is unable or unwilling to assume the life-cycle management of decentralized wastewater systems, a special management entity, such as a management district, can be formed where state statutes permit. This management option involves incorporating decentralized systems into a local or regional wastewater management district, with district personnel responsible for system operation and maintenance. Decentralized wastewater management districts have been in existence since 1972, when Georgetown, California implemented a community-wide onsite wastewater system management program in the Lake Auburn Trails subdivision (Shephard, 1996).

Table C-2 summarizes a number of decentralized wastewater management programs that have been implemented as management districts throughout the country. For a further discussion of management systems for decentralized wastewater treatment systems, see Shephard (1996).

Table C-2. Management Districts: Summary of Case Study Characteristics

Case Study	Funding Source	Size of Area	Waterbody Protected	Program Components
Crystal Lakes, CO	Annual dues ($60 per lot, $100 per lot if served by central water and sewer, $180 per lot if connected to seasonal central water and sewer)	4,000 lots	Crystal Lakes	Developer establishes and manages decentralized water and wastewater facilities in the subdivision. Management is funded through annual dues and includes, maintenance, removal of sewage from vaults, and delivery of drinking water to cisterns.
Crystal Lake, MI	Not Reported	1,100 homes	Crystal Lake	Establishment of new ordinances: (1) inspection/upgrade required prior to sale, (2) homeowners required to report on all systems, (3) health department required to inspect the systems, (4) systems must be upgraded within 120 days of inspection if failed, and (5) non-compliance meets with tough consequences.
Georgetown Divide, CA	Annual dues ($12.75 to $22.75), design costs ($540 per system), and hook-up fees ($875 per system)	3,000 acres	American River	Management entity is responsible for operations and maintenance, repair and inspection, system design, control of installation and siting, and control of building process. Inspection and maintenance program is database-controlled.
Kueka Lake, NY	$300 per year per parcel fee	Not Reported	Kueka Lake	Management entity responsible for evaluating, monitoring, and setting standards. Ordinances established include (1) the town had ultimate authority, (2) a mix of system designs was allowed, (3) annual inspection were required for highly technical systems, (4) systems within 200 feet of the lake must be inspected every 5 years, (6) systems must be inspected prior to property transfer, and (7) enforcement powers.
Stinson Beach, CA	Funds obtained from tax revenues, semiannual fee of $53, and charges for special inspections and inspection for compliance.	700 onsite systems	Groundwater/ Coastal waters	The District's management activities include inspection of system installation and routine system operation, and water quality monitoring. The district's rules and regulations specify the criteria to be used when issuing permits for new onsite systems, as well as for the repair and/or replacement of existing systems. Most of the systems in the community are inspected at least once a year; the systems that have been corrected or replaced, however, are inspected two or three times a year. District has a broad range of regulatory authority to perform onsite management functions.

Table C-2(continued)

Case Study	Funding Source	Size of Area	Waterbody Protected	Program Components
Guysborough, Nova Scotia	Initial Funds:$2,500 fee per equiv. unit or property, funds from Capital Assist.e Program (50% of total), and funds from the Council of the Municipality of Guysborough (26% of total) Funds for Management Program: Connection fee of $3,500. Annual property tax equal to the expected annual maintenance fee plus an amount to be set aside for future capital.	700 residents	Guysborough harbor	Built a Rotating Biological Contactor type sewage treatment facility to service the main core of the community. Second, a portion of the District was connected by sewer lines to an aerated lagoon system. The remaining properties within the District have been serviced by individual on-site systems. The municipality hired one employee to be responsible for the general maintenance of the treatment plant and lagoon systems. A preventative maintenance was established for the onsite systems
Cass County, MN	$3,800 per resident initial cost; annual fee of $12 to $15	110 miles, 85 towns	numerous lakes, streams	In 1994, the county developed an "Environmental Subordinate Service District," whereby a township, as the local unit of government, can effectively provide, finance, and administrate government services for subsets of its residents. Establishment of such districts within a town is authorized under MN Statute 365A. The purpose of these districts is to provide a self-sufficient, effective, and consistent long-term management tool, chiefly for neighborhood alternative (STEP) collection and communal leach fields. This innovative model stays at the grass roots level where the affected property owners and township are involved. Cass County provides technical and support assistance when required, but is not directly involved. The partnering with the townships and the county has allowed resource sharing, improved communication, and thus has opened up prospects for other cooperative ventures such as land-use planning, road improvements, and GIS use. Once a Subordinate Service District is created by petition and vote from the residents needing the specific service, a County/Township agreement is signed. The County then determines the system's design, handles construction oversight, gives final approval for the collection system, commits to yearly inspections, and assures regulatory compliance. The leach fields are located away from lakes, wells, and groundwater supplies. Cass County will allow systems to lie on county-administered land in order to defray residents' costs, or to enable optimal siting (Shephard, 1995).

Appendix D

Cost Estimation Methodology

COST ESTIMATION METHODOLOGY

The cost estimation methodologies for conventional gravity and alternative collection systems, as well as centralized treatment, cluster treatment, and onsite treatment systems, are presented in this appendix. The cost estimates include the capital cost necessary to install the system(s) and the annual cost to repair and maintain the system(s). Capital costs are annualized over 30 years (the life of the system) using a discount rate of 7 percent (OMB, 1996). All costs are presented in 1995 dollars. Cost data for the different technologies have been obtained from various sources, as documented in each section. Because the data reflect costs from different years, they have been indexed to 1995 dollars using the Means Historical Cost Indexes, as printed in the "Engineering News-Record (ENR)"(Means Heavy Construction Cost Data, 1996). Costs are indexed using the following equation:

$$1995\ Cost = 1987\ Cost\ x\ \frac{1995\ Index}{1987\ Index}$$

Indexes applicable to the costs presented in this appendix are:

Table D-1. Cost Indexes

Year	Index
1976	46.9
1978	53.5
1987	87.7
1991	96.8
1992	99.4
1995	107.6

COLLECTION SYSTEMS

Conventional Gravity Collection

A conventional gravity collection sewer collects and transports sewage to a centralized treatment facility via gravity. The system includes lateral pipes, collection sewers, interceptor sewers, manholes, and pump stations. Laterals are the pipes that transport wastewater from homes to the collection main sewers. Collection sewers are the pipes which carry the wastewater to interceptor sewers, which carry wastewater to the treatment system with the help of pump stations if needed. Manholes are included along the collection sewer to allow access for cleaning.

Because the pipes in a gravity collection system must continually slope downward, pump stations may be required to avoid excessive excavation for pipes or to reach a particular elevation at the system outfall. Pump stations (or lift stations) include pumps, valves, and a well to hold incoming sewage.

Cost Data

Cost estimates were developed for a conventional gravity collection system using cost equations developed by Dames and Moore. These equations were derived from actual installation and annual operating and maintenance (O&M) costs (Smith, 1978). The cost estimating procedure calculates costs in 1978 dollars because these were the best data available; the costs were then indexed to 1995 dollars.

Pipe Diameter - Dames and Moore provide an equation for estimating the capital costs of the lateral, collection main, and interceptor sewer pipes on a dollar per foot basis. This equation relates the cost of the pipe to the diameter of pipe required:

$$\frac{\$}{foot}\ (1978\ dollars) = 3.2\ x\ (pipe\ diameter)^{1.1667}\ x\ 1.03$$

Dames and Moore also provide an equation to determine the diameter of pipe required for the collection and interceptor sewer, based on the flow of wastewater through the pipe:

$$Pipe\ diameter = 17.74\ x\ Flow\ (mgd)^{0.3756}$$

A minimum pipe diameter of 8 inches was used for the collection and interceptor sewers (Fact Sheet, n.d.), unless a larger pipe size was required for the design flow. A pipe diameter of 4 inches was used for on-lot lateral pipes.

Pipe Length - The length of collection sewer required is dependent on the population density. Dames and Moore provide an equation for estimating this length:

$$\frac{feet\ of\ sewer}{capita} = 54\ x\ (\frac{persons}{acre})^{-0.65}$$

The length of interceptor pipe needed to transport the wastewater to a newly constructed treatment facility in the rural community is estimated to be about one mile. The length of interceptor pipe for the fringe community needed to transport wastewater to an existing facility in the metropolitan center was estimated between one and five miles. On-lot lateral pipes are estimated to be about 50 feet per home in the rural community, and 25 feet per home in the fringe community.

Lift/Pump Stations - The number of pump stations required in a system is dependent on the site topography. Dames and Moore estimate the number of pump stations to be one for every 18,000 feet of collection and interceptor length; however, additional pump stations are necessary if the topography is hilly or steep. The cost to install pump stations is dependent on the flow of wastewater and is estimated by the following equation:

$$\textit{Cost per station}\ (1978\ \$) = 0.168\ x\ (\textit{flow, mgd})^{1.08}\ x\ 1.03$$

A minimum cost of $50,000 (1995$) was used for construction of pump stations.

Annual costs to repair and maintain gravity collection sewers were also estimated from Dames and Moore data; average operating and maintenance costs for sewers is $1,502 per mile of sewer line (1978 dollars).

System Design and Cost

The following conventional gravity collection systems were designed and costed for the fringe and rural communities using the methodology presented above:

1) Installation of a conventional gravity sewer in the fringe community, with an additional 1-5 miles of pipe to connect this system to the existing sewer system in the metropolitan center.

2) Installation of a conventional gravity sewer in the rural community to be connected to a new rural community treatment plant located within one mile of the community.

Fringe Community Costs (1995 $)

The collection system for the fringe community is estimated to require about 25,000 feet of 10-inch diameter collection pipe, between 5,280 and 26,400 feet of 10-inch interceptor pipe, 11,000 feet of 4-inch lateral pipe, and three pump stations. The capital cost to install this system ranges from $3,322,900 to $5,377,800, depending on the distance of interceptor pipe required. The annual O&M costs are estimated to range between $23,000 and $35,000.

Rural Community Costs (1995 $)

Population density has a significant impact on the cost of collection, and ultimately makes up a large percentage of the cost to connect an area to centralized treatment. For this reason the cost of collection for the rural community was calculated using two population densities: a moderate density of 1 home per 1.5 acres and a low density of 1 home per 5 acres.

The collection system for the rural area when the population density is moderate is estimated to require about 15,500 feet of 8-inch diameter collection pipe, 5,280 feet of 8-inch diameter interceptor pipe, 6,800 feet of 4-inch diameter lateral pipe, and two pump stations. The capital cost to install this system is estimated to be $1,882,800 and the annual O&M costs are estimated to be about $15,750.

The collection system for the rural area when the population density is low is estimated to require about 34,000 feet of 8-inch diameter collection pipe, 5,280 feet of 8-inch diameter interceptor pipe, 6,800 feet of 4-inch lateral pipe, and three pump stations. The capital cost to install this system is estimated at $3,311,500 and the estimated annual O&M costs are about $26,300.

Alternative SDGS Collection

Alternative collection sewers are used in place of, or in conjunction with, conventional gravity collection sewers to collect and transport wastewater to a central treatment facility. Small diameter gravity sewers (SDGS) are a system of interceptor pipes and tanks and small diameter PVC collection mains. Onsite tanks are used to remove grease and settleable solids, allowing for the smaller diameter collection pipe to be used. The settled wastewater is discharged from the septic tank via gravity into the collector mains (EPA, 1991) . The collector mains then transport the wastewater to a local cluster system, a centralized treatment facility, or a conventional collection system. The main components of an SDGS are 3-inch to 8-inch PVC mains, cleanouts or manholes, vents, and septic tanks.

Cost Data

Several sources were reviewed to obtain cost data on SDGS systems. These sources include :

- EPA Manual on Alternative Collection (EPA, 1991)
- Fountain Run Case Study (Abney, 1976)
- Region IV Survey (EPA, n.d.)

The EPA alternative collection manual provides unit cost data (mid-1991) for interceptor tanks and 4-inch mains. The manual also contains design data and SDGS systems for several small communities; these communities were located in areas with steep and hilly topography. These systems were also designed to feed into central treatment facilities, instead of local cluster treatment systems. These differences are the reason why the sewer designs for these communities were not applied to the hypothetical communities.

The Fountain Run case study provides design information for a community divided into clusters ranging from 3 homes to 34 homes. The study did not indicate any prevailing topographic conditions which would hinder the construction of a SDGS. The study also provided unit cost data (1976) for the SDGS components, but these were not used since more recent unit cost information is available from the EPA alternative collection manual.

The Region IV survey contains design and project cost information on alternative collection systems. The SDGS projects were all designed to feed into centralized treatment facilities, therefore, these projects are not applied to the hypothetical communities.

System Design and Cost

The SDGS system was chosen to collect and transport wastewater to a local cluster treatment system. The homes in the fringe and rural communities were divided into smaller groupings, or clusters, based on their proximity to each other. Homes located in areas with poorly drained soils or high water table were also clustered together.

Design information for cluster systems of 3 to 34 homes was obtained from the Fountain Run Case Study. This information was combined with unit costs obtained from the EPA alternative collection manual. Homes with existing onsite septic tanks in good working order were not costed for replacement. Cost estimates for the installation of SDGS in the fringe and rural areas are provided below.

Fringe Community

The fringe area was grouped into 20 clusters. Table D-2 presents a summary of the capital cost and the length of sewer required for each cluster. As an example, the calculation of the capital costs for the 34-home SDGS cluster is presented below.

Table D-2. Fringe Area Clusters

Number of Clusters	Number of Connections	Capital Cost per Connection	Feet of Sewer per Connection
1	7	$2,633	174
6	10	$2,271	147
3	12	$1,723	83
10	34	$2,372	148
Total	383	$827,631	63,440

Septic Tank Capital Cost. This cluster contains 34 tanks. The EPA manual estimates the average installed septic tank cost to be $800 (1991 dollars). This yields a capital cost of $27,200 in 1991 dollars or $30,235 in 1995 dollars for the septic tanks in this cluster.

Sewer Main Capital Cost. The 34-home cluster requires 5,040 feet of 4-inch main. The EPA alternative collection manual estimates the cost per foot to install 4-inch pipe to be $9 per foot (1991). This yields a capital cost of $45,360 in 1991 dollars or $50,421 in 1995 dollars for the collection main in this cluster.

Total Capital Cost for Collection. The capital cost for collection is the sum of the capital cost for the units in the system incremented to 1995 dollars. For the 34-home cluster system the capital cost is $80,818, or a cost of $2,372 per home. Two hundred twenty homes in the fringe community have existing tanks which will be utilized by these cluster systems; therefore, the cost to replace these tanks ($195,636) has been subtracted from the total collection cost. The capital cost for collection in the fringe area is $827,631, as shown in Table D-2.

Operation and Maintenance Costs. The operation and maintenance cost for the SDGS system is included in the description of treatment for cluster systems, described later in this appendix.

Rural Community

For estimating the cost of cluster systems, the failing systems in the rural community were grouped into 4 clusters. Table D-3 presents a summary of the capital cost and the length of sewer required for each cluster. The capital cost of the SDGS clusters in the rural area were calculated using the same process as the fringe area.

Table D-3. Rural Area Clusters

Number of Clusters	Number of Connections	Capital Cost per Connection[1]	Feet of Sewer per Connection
2	10	$2,271	147
1	12	$1,723	83
1	35	$2,372	148
Total	67	$149,122	9,116

Capital Cost. The capital cost for collection in the rural area is $149,122, as shown in Table D-3.

Operation and Maintenance. The operation and maintenance cost for the SDGS system is included in the treatment part of the cluster system.

TREATMENT SYSTEMS

Centralized Wastewater Treatment

Many treatment technology options are available to communities that wish to employ centralized wastewater treatment. Community-specific characteristics, such as land cost and availability, wastewater characteristics and flow rates, desired treated wastewater effluent concentration, and solids disposal costs affect whether a particular treatment train may be the most cost-effective and reliable system for a particular community. For the hypothetical fringe and rural communities, different treatment trains are costed based on their expected community characteristics. For the rural community, due to the very small wastewater flow and the relatively large amount of land available, the treatment train costed includes a facultative oxidation pond, which requires a large amount of land but is economical and requires relatively little maintenance, and a chlorination/dechlorination disinfection unit. For the fringe community, the treatment train consists of a grit chamber, comminutor, sequencing batch reactor (SBR), and chlorination/dechlorination disinfection unit. The SBR was selected for the fringe community because it is capable of handling small wastewater flows and requires only a small amount of land, which may not be readily available in a fringe area. If removal of additional nitrogen is required, the facultative oxidation pond in the rural community is replaced by a SBR that provides nitrification and denitrification, and the SBR in the fringe community is modified to provide such treatment. Waste solids from the SBR unit is costed for disposal of via land application.

Cost Data

The costs for treatment of wastewater at centralized wastewater treatment facilities were estimated using the computer cost model Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR) (Gearheart et al, 1994). WAWTTAR was developed to estimate the feasibility and cost of water supply, wastewater collection, and wastewater treatment. The WAWTTAR cost model estimates costs in 1992 dollars, which are then indexed to 1995 dollars. Inputs to the WAWTTAR cost model include the community wastewater volume and characteristic data, treatment trains, and land costs, as well as target treatment performance standards.

The cost of land for construction of treatment facilities varies significantly from location to location. In some areas, the local government may already own the land necessary for construction of treatment facilities. In these instances, the land cost for treatment facilities will be minimal. However, many communities may need to purchase additional land to construct treatment facilities. The cost of the land will vary greatly from location to location. In the state of North Carolina, for example, land costs may range from $5,000 per acre in rural communities to $50,000 per acre in more developed areas (Hoover, 1996). Land costs for this report are based on an approximate average cost of $25,000 per acre.

The basic SBR and disinfection treatment system for the fringe community and the facultative oxidation pond and disinfection for the rural community are expected to reduce the biological oxygen demand (BOD) of the wastewater, as well as reduce suspended solids and fecal coliform bacteria.

These are parameters that would be included in most NPDES permits for municipal wastewater treatment facilities. The following treatment standards were input to the WAWTTAR cost model:

BOD	≤ 30 mg/L;
Suspended solids	≤ 50 mg/L; and
Fecal Coliform	≤ 200/100 ml.

The SBR modified to provide nitrification and denitrification, which was used for both the fringe and rural communities to remove nitrogen would meet the above standards and also reduce total nitrogen in the wastewater to 6 mg/L.

System Design and Cost

The cost estimates for centralized treatment of the wastewater from the rural community includes construction of a new treatment system dedicated to the community's wastewater. The cost estimates for centralized treatment of the wastewater from the fringe community includes expansion of the existing metropolitan center treatment plant to accomodate the additional flow. The centralized treatment costs discussed in this section do not include collection costs to transport the wastewater to the treatment facility, which were presented earlier in this appendix. Capital costs include the cost to purchase land on which to construct the facility, design, construction materials and equipment, and labor costs. Operating and maintenance costs include treatment chemicals such as chlorine and sulfur dioxide, energy to run equipment such as mixers, pumps, and aerators, and labor.

In some communities, existing wastewater treatment facilities may have sufficient capacity to treat additional wastewater from nearby community developments, such as the fringe community. Other communities may be capable of upgrading or expanding their existing wastewater treatment facilities; such modifications may range from minor operational changes to extensive upgrades and/or construction of additional facilities. The extent to which existing facilities must be modified to accommodate additional wastewater is highly dependent on site-specific factors, such as the existing capacity of the sewer and lift stations and treatment plant, and the effluent standards that must be met by the facility. Due to these highly site-specific factors, little or no capital investment would be necessary in some communities to enable an existing facility to treat additional wastewater, while in others upgrading the existing facility would be more expensive than construction of a completely new facility. Where existing facilities are used to treat additional wastewater, additional operating and maintenance expenses would be incurred from the use of additional oxygen and treatment chemicals, disposal of additional sludge, possible permit modifications, and other costs that are primarily and secondarily related to the volume of wastewater treated.

Fringe Community Costs (1995 $)

The capital cost to expand the existing metropolitan centralized wastewater treatment system consisting of a grit chamber, comminutor, SBR, and chlorination/dechlorination unit to accomodate the flow from the fringe community is estimated to be $464,000. Annual O&M costs are estimated to be $61,000.

Rural Community Costs (1995$)

The capital cost to install a centralized wastewater treatment system consisting of a facultative oxidation pond and a chlorination/dechlorination unit to service the rural community is estimated to be $439,000, while annual O&M costs are estimated to be $14,000.

Cluster Systems

A cluster system treats wastewater from a localized group of homes and is often used in conjunction with an alternative collection system. Cluster systems may include a central leach field for subsurface discharge, or may discharge to surface waters. The cluster systems evaluated for the rural and fringe communities consists of onsite septic tanks, and central sand filters and leach fields. The main components of a central leach field are dosing siphons/tanks, pumps, adsorption trenches, and land. The main components of a sand filter are pumps, dosing tanks, and the filter.

Cost Data

Cost estimates were developed for a central leach field to serve a cluster of homes. The Fountain Run case study (Abney, 1976), which was used to develop alternative collection costs, also provides design information on leach field treatment. The case study provides capital cost data for a community divided into clusters ranging from 3 to 34 homes. The study includes unit cost data (1976) for leach field treatment, including construction of the adsorption trenches. More recent cost data were used for sand filter treatment for cluster systems (Otis, 1996) and for land. As with centralized treatment, the cost for land is based on the approximate average cost of $25,000 per acre for North Carolina (Hoover, 1996).

Operating and maintenance costs include pumpout of the individual septic tanks and replacement of distribution pump every 10 years, and quarterly inspections of the cluster systems. Cost data were obtained from the COSMO cost model (Renkow and Hoover, 1996) developed at North Carolina State University and are described in detail in the onsite system section, described later in this appendix.

System Design and Cost

The homes in the fringe and rural communities were divided into smaller groupings , or clusters, based on their proximity to each other. Homes located in areas with poorly drained soils or higher water table were also clustered together.

Design information on leach fields for cluster systems of 3 to 34 homes was obtained from the Fountain Run case study, and was combined with the average cost per acre of land to comprise the capital cost for the leach field system. The capital cost for sand filter treatment is based on wastewater flow, and is estimated to be $15 per gallon (Otis, 1996). Operating and maintenance costs were obtained from the COSMO cost model. Cost estimates for the installation of treatment systems in the fringe and rural areas are provided below.

Fringe Area

To correspond with alternative collection costs, the fringe community was broken into 20 clusters. In the fringe community, cluster systems were costed for sand filter treatment followed by a leach field. Table D-4 presents a summary of the capital cost for cluster systems in the fringe community.

Table D-4. Fringe Area Clusters

Number of Clusters	Number of Connections	Capital Cost per Connection
1	7	$6,598
6	10	$6,914
3	12	$6,529
10	34	$6,639
Total	383	$2,953,421

Capital Cost. The cost for the leach field treatment follows the methodology outlined in the alternative collection section. The sand filter treatment cost was estimated as $15 per gallon of wastewater treated. Using the basis of 175 gallons of wastewater produced per home, a sand filter treatment system is estimated to cost $2,625 per home. The capital cost for treatment in the fringe area is $2,953,421, as shown in Table D-4.

Operation and Maintenance Cost. The operation and maintenance (O&M) cost for the combined collection and treatment cluster was obtained from the COSMO cost model. Maintenance of the onsite systems, including yearly inspections and pumpouts every 10 years cost $32 per year. Quarterly inspections of the central leach field cost $100 per year; additional inspection time for the sand filter is expected to cost an additional $25 per year. Pump replacements are expected to occur three times over the life of the system and cost a total of $1,800.

Rural Community

To correspond with alternative collection costs, the failing systems in the rural community were broken into 4 clusters. Table D-5 presents a summary of the capital cost for each cluster.

Table D-5. Rural Area Clusters

Number of Clusters	Number of Connections	Capital Cost per Connection
2	10	$6,914
1	12	$6,529
1	35	$6,639
Total	67	$448,992

Capital Cost. The cost for the leach field treatment follows the methodology outlined in the alternative collection section. The sand filter treatment cost was estimated as $15 per gallon of wastewater treated. Using the basis of 175 gallons of wastewater produced per home, a sand filter treatment system is estimated to cost $2,625 per home. Sand filter costs are added to the costs for the 4 cluster systems (serving 67 homes) located in areas with poor soil conditions. The capital cost for cluster treatment in the rural community is $448,992, as shown in Table D-5.

Operation and Maintenance. The operation and maintenance (O&M) cost for the combined collection and treatment cluster was obtained from the COSMO cost model. Maintenance of the onsite systems, including yearly inspections and pumpouts every 10 years cost $32 per year. Quarterly inspections of the central leach field cost $100 per year; additional inspection time for the sand filter is expected to cost an additional $25 per year. Pump replacements are expected to occur three times over the life of the system and cost a total of $1,800.

Onsite Treatment

Onsite systems treat wastewater from individual homes, thereby eliminating the need for a centralized collection and treatment system. A conventional onsite system consists of a septic tank, gravity distribution leach field, and the soil beneath the leach field (Hoover and Renkow, 1997). Solids from the wastewater deposit in the septic tank where anaerobic decomposition occurs. The effluent is dispersed throughout the leach field where it infiltrates the soil. Additional treatment, such as aerobic decomposition, occurs in the soil.

Because of site-specific conditions, some onsite systems require additional treatment units or use different methods of distributing the wastewater to the leach field. Two system modifications evaluated for the hypothetical community were low pressure pipe (LPP) distribution and sand filter treatment. Systems that utilize LPP distribution include a pump, pump tank, floats and controls, and a pressure distribution system, including small diameter (1.25-inch) PVC lateral pipes with small perforations.

Cost Data

Onsite treatment costs were estimated using the COSMO cost model (Renkow and Hoover, 1996). Equipment and labor costs (1995 dollars) reflecting the Wisconsin area were obtained and entered into COSMO to develop cost estimates. However, it should be noted that onsite treatment costs vary by region and may in fact be more or less cost-effective depending on site-specific conditions and costs.

Onsite capital costs include upgrades (i.e., replacement systems) for failing systems in the rural and fringe communities, as well as new systems for the future development in the fringe community. Operating and maintenance costs include quarterly inspections of the onsite systems, including septic tanks, leach fields, and sand filters. O&M costs also include pumpouts of the septic tanks and replacement of the distribution pumps every 10 years. The establishment of one district to provide wastewater management to the fringe and rural communities assumes the district will take over maintenance of all existing and future onsite systems; therefore, the annual O&M cost estimates include costs for the existing onsite systems that are still functioning effectively.

System Design and Cost

Two onsite treatment systems were evaluated for the hypothetical community:

- Septic tank with low pressure pipe (LPP) distribution to a leach field
- Septic tank with sand filter treatment and LPP distribution to a leach field

LPP systems were chosen because they provide dosing and resting cycles in the leach field and distribute the wastewater more effectively throughout the system. LPP distribution is effective in areas with poor drainage, such as some of the homes in the hypothetical rural and fringe communities. Sand filters provide additional treatment to meet performance goals in systems located in ecologically sensitive areas and/or areas with high water tables, such as the homes located near the river in the rural community..

Rural Community

About half (67) of the 135 onsite systems currently in operation in the rural community are failing. Twenty of the 67 failing systems are located in an area near the river with a high water table. These systems need to achieve better quality discharge; therefore, the cost estimates include installing a new onsite systm equipped with a septic tank, a pressure-dosed single pass sand filter and a low pressure pipe distribution system to a leach field. Forty-seven of the 67 failing systems are located in areas with poor soils; the cost estimates include installing a new septic tank with a low pressure pipe distribution system to replace these systems. Capital costs for the rural area are estimated to be $510,000.

Annual O&M costs include maintenance of the 67 newly upgraded systems, as well as maintenance of the 68 current systems that still function effectively. These existing systems consist of a septic tank and gravity distribution system to a leach field. Annual O&M for the rural area is estimated to be $13,400.

Fringe Community

About half (110) of the 220 onsite systems currently in operation in the rural community are failing. Thirty-three of these failing systems are located in an area near the river with a high water table. These systems need to achieve better quality discharge; therefore, the cost estimates include installing a new onsite system equipped with a septic tank, a pressure-dosed single pass sand filter and a low pressure pipe distribution system to a leach field. Seventy-seven of these failing systems are located in areas with poor soils; the cost estimates include installing a new septic tank with a low pressure pipe distribution system to replace these systems. The cost estimates for onsite treatment in new fringe community homes also include installing new septic tanks with low pressure pipe distribution to a leach field for all future homes (223 systems). Capital costs for the fringe community is estimated to be $2,117,095; O&M costs are estimated to be $59,240.

Appendix E

Case Studies

(Excerpted from "Managing Wastewater: Prospects in Massachusetts for a Decentralized Approach")

Nova Scotia, Canada

The noncontiguous district

A law passed in 1982 allows Nova Scotia towns and municipalities to create Wastewater Management Districts. The idea is to provide uniform "flush and forget" services to building owners, regardless of the mix of technologies and regardless of who owns the systems. All property owners in the district are obliged to participate in the funding, paying an annual charge that covers capital recovery as well as operation and maintenance costs. Boundaries of the district need not coincide with the existing town boundaries, and would typically be smaller.

In fact, the district may be "noncontiguous," consisting of individual properties or groups of properties that require special consideration for environmental or historical reasons. The administrative institution is either a sewer or public works committee of the municipal council. It is vested with all the necessary authorities and duties. It can own or lease land, make contracts, and fix and collect charges. It is held responsible for overall planning; upgrades; and design, construction, inspection, operation and maintenance of all types of systems. Finally, it can enter private property to inspect, repair, or replace malfunctioning systems.

In Port Maitland (population 360), a preliminary study estimated a per household cost of $6000 to $10,000 to install a conventional plant. The town opted instead for a mix of individual onsite systems and four cluster systems fed by gravity sewers to central septic tanks, siphon chambers, and contour subsoil trenches. Installation costs were approximately $2400 per unit. Maintenance, repair, and pumping are provided by private contractors with the District. Annual fees per household were $65 in 1994. Recent studies have shown that despite seasonally high groundwater, the systems are functioning well.

Guysborough, with a similar population, adopted a plan that includes a small conventional treatment plant for part of the town, an aerated lagoon for another part, and individual onsite systems for a third part. All owners were assessed $2100 initially, and were charged annual fees of $125 in 1994.

Voter approval of those in the district is required; it must be presented to them as a complete plan that has considered sites, boundaries, servicing options, preliminary designs, and cost estimates. However, districts have often been voted down. Only three Nova Scotia towns had adopted such districts by the spring of 1994. Of sixteen others that considered it, decentralized management was actually recommended in fourteen cases. But six had chosen to centralize, and five were still in nebulous discussion. Five others were actively considering OWMD programs. Equity of either service or cost has been an issue in towns considering a mixed approach. Furthermore, central sewering is often regarded by the public as more desirable and less interfering. Aside from questions of equity, voters have not always perceived that a problem existed, or that a Wastewater Management District was the entity to fix it.

Sources

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Cass County, Minnesota

Rural electric cooperatives manage service districts

Cass County is typical of the counties in the "Northern Lake Ecoregion" which have evolved from an economy based on agriculture and timber to an economy where the lakes and associated tourism have become very important. Because much of the development and growth around the lake regions took place in earlier years, there wasn't great attention paid to lot sizes, soil types, or to consideration of water quality. Cass County is now faced with a growing number of nonconforming onsite septic systems around many of its rural lakes. Furthermore, the state Shorelands Management Act, and Minnesota Pollution Control Agency (MPCA) regulations, are setting tighter regulatory wastewater standards which Cass County is obliged to enforce. And many residents are in the unfortunate position of being unable to sell their homes due to the fact that they can not provide a "conforming" septic system on their property. Cass County has been pressed to look for answers.

In 1994, the county developed the concept of the "Environmental Subordinate Service District," whereby a township, as the local unit of government, can effectively provide, finance, and administrate governmental services for subsets of its residents. Establishment of such districts within a town is now authorized under Minnesota Statute 365A. So far, one district has been formed; five are in planning stages. The purpose of these districts is to provide a self-sufficient, effective, and consistent long-term management tool, chiefly for neighborhood alternative (STEP) collection and communal leach fields. This model is innovative, because it stays at the grass roots level where the affected property owners and the township remain involved. Cass County provides technical and support assistance when required, but is not directly involved on a daily basis. The partnering with the townships and the county has allowed resource sharing, improved communication, and thus has opened up prospects for other cooperative ventures such as land-use planning, road improvements, and geographic information systems.

Once a Subordinate Service District is created by petition and vote from the residents needing the specific service, a County/Township agreement is signed. The County then determines the system's design, handles construction oversight, gives final approval for the collection system, commits to yearly inspections, and assures regulatory compliance. The leach fields are located away from lakes, wells, and groundwater supplies. Cass County will allow systems to lie on county-administered land in order to defray residents' costs, or to enable optimal siting.

The township is the legal entity that secures management services needed for the district to function. Other key players are the MPCA's Brainerd Regional Office, providing regulatory and technical assistance, the Association of Cass County Lakes for lake and water quality monitoring and educational support, the Minnesota Association of Townships for their legal counsel, the Mutual Service Insurance Agency for insuring the townships and the district wastewater collection systems, the Tri-County Leech Lake Watershed (district) for their engineering funding, and the Woodland Bank of Remer for working with the township to obtain low interest financing for residents.

However, **another key and major** player is the Rural Utilities Services (formerly the Rural Electrification Association). The piece of the puzzle missing for the districts to actually work was an operations, maintenance, and management program. Therefore, Cass County sought out the local utility, Crow Wing Power and Light (Brainerd, MN), and asked them to consider helping. Crow Wing Power and Light now provides the following services as utility managers: (1) security monitoring; (2) monthly inspections (they also maintain the grounds); (3) through a subcontractor, pumping of individual septic tanks, and any other repair or maintenance required; and (4) record keeping—logs are kept of inspections and repairs/maintenance. Bills are sent to the residents involved every six months, totalling about $200 per year per household.

A management maintenance contract is negotiated for the utility's services, thus reducing the need for additional staffing by the town itself. The township remains the legal entity guaranteeing any unpaid charges through its power to levy special district taxes.

Source

This (extracted) text has been supplied by Bridget I. Chard, Resource Consultant, Red River Ox Cart Trail, Rte 1, Box 1187, Pillager, MN 56734; tel. 218-825-0528.

Stinson Beach, California

Another classic, enforceable by shutting off town water

Stinson Beach is a small town in Marin County, located about 20 miles north of San Francisco. Part of the beach is a park that can draw 10,000 visitors on a weekend. The town *generally* answers to Marin County government. At present there are about 700 onsite systems in Stinson Beach. It is another early participant in the onsite management concept.

In 1961 a county survey concluded that surface and groundwaters were being polluted by many of the town's often antiquated onsite systems. In response, the county created the Stinson Beach County Water District, whose task would be solve the problem. The water district is governed by a five-member, elected Board of Directors who make policy and perform water quality planning. Between 1961 and 1973, nine separate studies and proposals for central treatment were rejected by voters. In 1973 the San Francisco Regional Water Quality Control Board (SFRWQCB) intervened, putting Stinson Beach on notice. All onsite systems would be eliminated by 1977, and a building moratorium would go into effect forthwith. Even so, a *tenth* central sewer proposal was rejected. Voters were not only alarmed by costs, but were unconvinced that alternatives had been sufficiently considered. An eleventh study, specifically undertaken to examine alternatives, concluded that onsite remediation was both the most cost effective and environmentally benign.

Concurrence was sought from both the regional board and the state legislature, which enacted special legislation (consistent with California Water Code provisions) in 1978 empowering the Stinson Beach County Water District to establish the Stinson Beach Onsite Wastewater Management Program. The program would answer directly to the SFRWQCB, rather than to Marin County. The program would govern the permitting, construction, inspection, repair, and maintenance of old and, later, new systems. Rules and regulations were approved by the regional board on a trial basis, and were later made permanent. The program went into effect with the passage of a series of town ordinances. Rules and regulations (and ordinances) have evolved as problems were encountered, there being few precedents to go on.

Ownership of the systems, and ultimately the responsibility for repairing or upgrading them, rest with the building owner. But program staff perform inspections out of which come permits to operate, or instead a citation that lists violations and provides a timetable for remediation. (Initially a house-to-house survey was used to identify the most critical failures or substandard systems from which came *interim* permits to operate.) As in the case of Georgetown, the permit to operate is conditional on authorizing the district to enter property for purposes of inspection and, if need be, repair. Conventional systems are inspected every two years, alternative systems (now stipulated for some areas) every quarter. The permit may carry conditions, or varying periods of validity. The regulations provide penalties for noncompliance of up to a $500 fine or 60 days imprisonment, each day considered another count. The district also has the power to effect its own repairs and put a lien on the property until repaid. And it has access to low-interest state loan funds for low-income households. However, *it has rarely had to take strong measures because the district is also empowered to cut off the water supply of a noncomplier*, something it has had to do occasionally. During the initial period, about half the existing systems were found to require repair or replacement.

Five staffers approve plans, and inspect and handle compliance. The budget is met partly out of tax revenues and partly by a $53 per household semiannual fee. Special inspections or inspections for compliance are also charged for.

Problems encountered at Stinson Beach mostly had to do with delays as bugs were worked out and sudden demands were put on staff as well as private engineers and installers. One completely unanticipated problem: Access ports, required of system owners, were leading to a serious mosquito problem; redesign of the ports resulted. Then, in 1992, the RWQCB imposed a moratorium on new systems pending reevaluation of the program, revised (and tighter) technical, approval and tracking procedures, and the development of a more adequate staffing and fee structure. New ordinances were passed in 1994, and the program is back on track. Not without some growth pains, this 17-year old program is regarded as both successful and adaptable to other locales.

Sources

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Keuka Lake, New York

A home-rule intermunicipal agreement, eight towns strong

Lake Keuka lies in upper New York State's "Finger Lakes Region." The Keuka watershed supplies water for over 20,000 people; over 10,000 live on the lake's shores, which border 8 municipalities and two counties. Overall, water quality in the lake is good, but occasionally elevated levels of sediment, nutrients, and pathogens have been recorded. Pollution, and its potential impact on health, recreation, property values and the associated tourism industry, led local townspeople to identify watershed management as their leading concern.

This concern was uncovered by a civic group, the Keuka Lake Association; more than 30 years old, it ultimately comprised 1700 members and was able, via its nonprofit Foundation, to acquire $180,000 in grants and other revenues for study and planning purposes. It went on, in 1991, to establish the Keuka Lake Watershed Project, whose more specific purpose was to promote uniform, coordinated, cooperative watershed management for the region. There were three prongs to its effort: (1) establish details of the current situation; (2) educate the public to the need for action; and (3) foster inter-institutional cooperation.

With regard to the latter, it encouraged the formation of individual Town Watershed Advisory Committees that would provide local participatory forums to address water issues, and at the same time report to the Project's director. An early suggestion of the individual committees was to form a single, oversight committee, consisting of elected officials from the eight municipalities around the lake. This committee came to be called the Keuka Watershed Improvement Cooperative (KWIC). Initially it had no official status.

The stated purpose of the Cooperative was to develop a model watershed law, and then identify who should administer it. In developing the law it specifically excluded facilities of such a size that they were already regulated by the state. When it came to administration, they examined and rejected forming a regulatory commission through the state's enabling procedures, and they examined and rejected county-based ("county-small") watershed districts. Instead, they opted for drawing up an intermunicipal agreement under the state's Home Rule provisions which allow the municipalities to do anything together (by agreement) that they could have done separately. The agreement, itself, was only 8 pages long. It legally formalized the cooperative, providing for a board of directors consisting of the Chief Executive Officer of each municipality, and for a professional watershed management staff. Voters were presented with a package consisting of the agreement, the proposed watershed protection law, and recommended policy and procedures, including those for dispute resolution. After dozens of public meetings the package won by a landslide in every municipality.

Regulations govern permitting, design standards, inspection and enforcement. A program for all sites in "Zone One," the land within 200 feet of lake, calls for their inspection at least once every five years. Failures are cited and required upgrades stipulated. Aerobic and other alternative systems must be inspected annually, at which time the owner must show evidence of an extant maintenance contract. Specifications for the design, construction, and siting of replacement systems are also tighter than the state's, and approval may require the use of advanced or "Best Available Technology." Enforcement provisions define violations, and specify timetables for compliance and fines. The individual municipalities issue notices of violations and citations to appear in town or village court.

The Cooperative coordinates its activities with state and county health agencies, maintains a database and GIS system to track environmental variables and the performance of new technologies, continues with ongoing studies, and retains a Technical Review Committee to help with policy and regulatory modifications. Staff include a full time watershed manager, employed by KWIC, and part time inspectors, employed by the towns.

KWIC is financed by septic system permit fees, grants as available, and funds from each member municipality's annual budget. The annual KWIC budget forecasts permit fees, considers grant funds immediately available, and distributes the balance of funds needed evenly among the towns and villages.

Sources

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Gloucester, Massachusetts

Exploring new approaches for Massachusetts' cities

Gloucester is a fishing port (population, 30,000) on the rocky coast of Cape Ann, about 40 miles north of Boston. While 40% of the city is sewered, the particularly troublesome area of North Gloucester is not. Failed septic systems have resulted in the closing of shellfish beds, and since 1979 the city has been under a consent decree to comply by 1999 with state clean water standards. Numerous environmental problems were initially taken to imply that North Gloucester should be required to hook into the city sewer. These included shallow soil depth, a high groundwater table, wetland areas, and numerous private wells.

The hookup was partially underway when the EPA Construction Grants program was terminated in 1985, leaving Gloucester still with a problem, and still under a consent decree. Aware that centralized hookups would now become extremely expensive to homeowners, and also aware that the central sewer provided only primary treatment (albeit waivered for the time being), the city began an examination of the many ramifications of decentralized management, and many discussions with the state's Department of Environmental Protection.

In ongoing negotiations for its consent decree, Gloucester is pioneering a new approach to wastewater management in Massachusetts. It is in the process of developing a citywide wastewater plan that avoids construction of additional conventional sewer lines by proposing STEP sewers and/or ensuring that all onsite systems are properly built and maintained. Small community systems and package plants would be administered by the city's Department of Public Works, although their ownership is still under discussion.

Individual systems would still be administered by the Board of Health, albeit in a framework tougher than the state's recently revised (Title 5) regulations. As it presently stands, key provisions relating to individual systems include the following: An initial inspection and pumping will be conducted by either Board of Health personnel or privately-licensed inspectors at the homeowner's option. Inspection will result in either an Operating Permit or an Order to Comply that stipulates upgrade or replacement requirements and a time frame for compliance. Regular inspections will follow, ranging from annual (for food industries) to every seven years (for residences). A BOH computer system now in development will record data from these inspections as well as from septage haulers. There are emergency repair provisions and financial relief (loan) provisions for qualifying homeowners to be funded through a

Betterment Bill bond issue. The system is to be financed by license fees from professionals and by inspection fees from homeowners. Contractors and haulers will be licensed annually by the city, which will also conduct training programs. Enforcement will rely on the ultimate power of the BOH to make repairs itself and then invoice, with collection falling to the city and courts.

In areas unsuited for conventional systems, alternative technologies permitted by the DEP will be stipulated. For those, technical advice can be obtained from the DPW as well as the BOH. Such systems must be accompanied by three-year maintenance contracts with either the DPW or a licensed manufacturer/installer. In North Gloucester a National Onsite Demonstration Project is underway to test innovative systems yet to receive general state approval. Not all details of Gloucester's plans are settled, and final approval has yet to be obtained from the DEP, which, however, is being consulted as the plan is developed.

Sources

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Appendix F

The Role of Rural Electric Cooperatives in Upgrading Facilities

THE ROLE OF RURAL ELECTRIC COOPERATIVES IN UPGRADING FACILITIES

BACKGROUND

Rural electric cooperatives are private entities that build and manage extensive rural utility systems. These cooperatives have the capability to address a full range of technical, financial, administrative, and regulatory issues related to the supply and management of electrical power. A report titled, "COMMUNITY INVOLVEMENT - Opportunities in Water-Wastewater Services, The Final Report of the NRECA/CFC Joint Member Task Force on Rural Water and Wastewater Infrastructure, February 1995" (CI Report), produced jointly by the National Rural Electric Cooperative Association and the National Rural Utilities Cooperative Finance Corporation, sets forth a "blueprint for rural electric cooperatives which decide to enter the water-wastewater business voluntarily." In the Fiscal Year 1997 House Appropriations Committee report, the Committee acknowledged the significant interest of the cooperatives "to expand their current role of delivering electricity to the delivery to rural communities of clean water and safe drinking water improvement technologies as well." The Committee "is uncertain whether expansion into this new field is an appropriate means of upgrading rural drinking and wastewater facilities to meet federal requirements." EPA was asked to review this matter and report on its findings prior to the Committee's fiscal year 1998 budget hearings for EPA. This response examines whether cooperatives are an appropriate vehicle to manage, operate, maintain and upgrade drinking water and wastewater systems. It is included as an appendix to an overall response to Congress on decentralized wastewater treatment systems.

There are approximately 900 rural electric cooperatives in the United States. An estimated 80 to 90 of these cooperatives are involved in some aspect of drinking water or wastewater management with the overwhelming majority dealing with drinking water management. Only a few of the cooperatives own wastewater treatment facilities or are currently involved in wastewater management.

KEY ISSUES

To determine whether cooperatives are appropriate management entities for managing drinking water and wastewater systems, there are several key issues to consider:

1. Authority for ownership/management,
2. Managerial and technical ability,
3. Ability to obtain capital, and
4. Ability to ensure continued management and operation and maintenance (O&M).

These issues are examined below for the purpose of determining whether cooperatives are appropriate for upgrading drinking water and wastewater facilities to meet federal requirements.

1. Authority for Ownership/Management. The CI Report notes that most states - all but 13 - have laws that authorize cooperatives to own and operate drinking water and wastewater facilities. The CI Report notes "...some cooperatives have used innovative methods to gain entry to the drinking water and wastewater business. Cooperatives. . . may be eligible through other methods of organization."

In addition to state and local authority, in the wastewater area, cooperatives must have each individual owners' agreement to upgrade and/or operate and maintain their onsite wastewater systems. This generally happens when a large percentage of homeowners have failing onsite systems and have a need for upgraded treatment which they cannot meet themselves, and for which local government is incapable or unwilling to meet. The owners retain the services of a cooperative which would seek the capital needed for the system upgrade. The cooperative would be charged with the responsibility for operation and maintenance of the system and charge a monthly utility rate for this service and the cost of needed upgrades.

In cases where centralized wastewater collection and treatment systems or water distribution systems already exist, but fail to meet the federal statutory or regulatory requirements, the same situation occurs. If the facilities are inadequate, the system owner must invest in improvements. An organization, such as a cooperative or other private entity, may take ownership of the system and provide operation and maintenance. Issues associated with privatization of wastewater are discussed in a companion document entitled, "Response to Congress on Privatization of Wastewater Facilities".

One area related to wastewater where cooperatives are having success is where state or local health officials have ruled that conventional onsite wastewater systems will not work due to soil conditions. In these cases, developers are usually not familiar with alternative systems and welcome cooperatives to take ownership and/or manage the new upgraded systems that they are required to install. There are two driving forces that are bringing this about: 1) the need for some form of wastewater treatment other than conventional septic systems, and 2) the revenue generated by each new homeowner (customer) for electric power (estimated at about $1,000 / yr / household).

A second area of success has been assistance and contract management to drinking water authorities, both public and private. The CI Report indicates that types of services currently provided include organizing, feasibility, bylaws, mapping, accounting and billing.

2. Managerial and Technical Ability. Cooperatives do not generally have the technical ability "in house" to conduct drinking water and wastewater feasibility studies and facility designs (with the exception of those which currently own or operate drinking water and/or wastewater facilities). However, they are well equipped with managerial capabilities and can contract for these technical services. In addition, cooperative associations have contracted with several drinking water and wastewater research-oriented professionals who provide technical assistance, including demonstrations of technology, thus giving them access to technically competent people. At least one state cooperative association is already performing demonstrations of alternative technologies (in Pennsylvania, five onsite system projects will be demonstrated).

Rural electric cooperatives have historically dealt with issues relating to the use of electricity to enhance the lives of inhabitants of rural areas in the context of economic development. Conventional onsite systems (septic tank and leach field) typically do not involve the use of electricity, while centralized systems and alternative types of onsite systems generally rely upon electricity for pumping, power, lighting and other activities. Therefore, there could be a possible concern that rural electric cooperatives might be more comfortable with constructing or managing facilities which rely on electric power versus those that do not. This concern would need to be addressed if rural electric cooperatives are to play a more prominent role in the construction and/or management of decentralized treatment systems. It should be noted that the Federal Agriculture Improvement and Reform Act of 1996 (the Farm Bill) prohibits cooperatives from requiring those receiving drinking water and wastewater services to receive electric services.

3. Ability to Obtain Capital. In the CI Report (chapter 9), there is considerable discussion of the various possible funding scenarios. Federal funding, including loans, grants, and guarantee programs, for drinking water and wastewater programs is provided by the following federal departments and agencies:

- o USDA's Rural Utilities Service (RUS)
- o USDA's Rural Business and Cooperative Development Service (RBCDS)
- o USDA's Rural Housing and Community Development Service (RHCDS)
- o U.S. Department of Commerce's Economic Development Administration (EDA)
- o U.S. Department of Housing and Urban Development (HUD)
- o U.S. EPA

There are many opportunities for funding other than federal programs, including loans from local financial institutions. In addition, two other sources of funding are the National Rural Utilities Cooperative Finance Corporation (CFC), and National Bank for Cooperatives (CoBank). The cooperatives' [illegible] skills and equity provide support that other private or governmental organizations may not provide in rural areas. However, issues related to ownership and management of the facilities may limit where funds can be obtained. The CI Report provides six recommendations to Congress to strengthen the ability of cooperatives to obtain funding. These recommendations include: authorization for a re-lending program for system upgrades; funding for the W[illegible]-Wastewater Disposal Loan Guarantee program; removal of the "no-credit-elsewhere" condition in the loan program; financing for feasibility studies; eligibility for cooperatives to receive funds under all federal programs; and support for rural electric infrastructure activities.

4. Ability to Ensure Continued Management and O&M. Chapter 8 of the CI Report provides a strong basis for the ways that cooperatives can assist in management and O&M. Cooperatives are more likely to provide better management and O&M than small public (town) or private entities (e.g. homeowners' associations) which cannot afford to staff up appropriately and typically run into political and financial conflicts. The ability to provide management, including O&M, could be the strongest and most valuable asset the cooperatives offer. The real problem in the wastewater area involves convincing the homeowners there is a need for management services, including O&M of the onsite wastewater system starting from its initial installation.

CONCLUSIONS

In summary, drinking water and wastewater treatment facilities can be upgraded and managed by rural electric cooperatives, although 13 states would require enabling legislation for them to own and/or operate these facilities. Upgrades of drinking water and wastewater facilities by cooperatives could be a good solution in rural areas because cooperatives are non-political, known entities to the homeowners, they bring experienced management and staff to solve the O&M challenge, as well as options for obtaining capital. Also, the ability to provide management services, including O&M, can be the cooperatives' most valuable asset.

From the drinking water perspective, cooperatives offer great promise as management entities for small water systems which lack institutional strength. However, for many reasons, some stated above, it is unlikely that the cooperatives will make significant movements into the drinking water and wastewater business quickly. These reasons involve interest on the part of individual owners to pay for onsite system management, the technical ability of the cooperative to manage drinking water and wastewater facilities, limited experience with low energy onsite technologies, and the ability to obtain capital. Once these issues are resolved, the communities and cooperatives may be able to work together to efficiently provide the needed improvements and services.